Research Note 84-32

UH-60A (BLACKHAWK): A CASE STUDY OF MANPOWER, PERSONNEL AND TRAINING REQUIREMENTS DETERMINATION

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This report describes and analyses the procedures used to determine manpower, personnel and training (MPT) requirements for the UH-60A BLACKHAWK Helicopter Program and related accomplishment of actual MPT events/documents to those called for in the Life Cycle System Management Model (LCSMM). It addresses concerns being raised about the acequacy and timeliness of the Army's MPT requirements determination procedures.

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FOREWORD

The Army is currently implementing a broadly based force modernization program featuring the introduction of a large number of sophisticated new materiel systems and simultaneous redesign of its force structure (Division 86) in an all-volunteer environment. This ambitious effort places heavy demands on the Army's manpower and training resources. Projected declines in the qualitative and quantitative manpower pool from which the Army must recruit its future soldiers will compound that problem over the next several years.

A necessary early step in coping with the Manpower, Personnel, and Training (MPT) resource problem is the production of an accurate and timely accounting of the number of people and skills needed, system by system and in the aggregate, to operate and maintain new equipment once fielded. To this end, the Army has developed an elaborate materiel acquisition process and a number of regulations and instructions which address the MPT issues to be considered during system development and acquisition. Nevertheless, a number of negative judgements, summarized below and generally supported by previous study findings, have been made about the Army's ability to determine MPT requirements for new systems.

- Tools and techniques for predicting manpower requirements and guidance for their application are both inadequate and unevenly applied.

- The process whereby MPT requirements are documented and transmitted is overly complex, slow, and fails to include direct early participation of Army personnel community representatives.

- o Materiel developers often fail to understand the impact that MPT requirements have on the ultimate cost and operational utility of a new piece of hardware once fielded; consequently, insufficient funds and effort are devoted to MPT analysis and human factors engineering during early stages of system development.

Jointly sponsored by the Defense Systems Management College (DSMC) and the US Army Research Institute for the Behavioral and Social Sciences (ARI), this study effort by Information Spectrum, Inc. under contract MDA 903-81-C-0386 is one of several initiatives designed to resopnd to concerns being raised about the adequacy and timeliness of the Army's MPT requirements determination procedures. It supports ARI's intensive system manning technology research and development program and DSMC's increased educational emphasis on performance of more effective man-machine tradeoffs during early stages of the materiel acquisition process.

This report is one of five resulting from ISI's research effort. Each of the first four is a case study that describes and analyzes the procedures used to determine MPT requirements for a specific materiel system, and relates accomplishment of actual MPT events/documents to those called for in the Life Cycle System Management Model (LCSMM). A fifth report analyzes findings from the four case studies, draws systemic conclusions, and makes recommendations for improving the MPT requirements determination process.

EXECUTIVE SUMMARY

BACKGROUND

Growing concern with the soldier-machine interface problem, the future manpower pool available to the Army, and the Army's ability to make accurate and timely determinations of the quantitative and qualitative Manpower, Personnel, and Training (MPT) requirements for newly developed systems provided the impetus for the study of several emerging materiel systems. This report examines the UH-60A (BLACKHAWK) Program, one of four systems selected for study. A comparative analysis report examines the results of the four system case studies, identifies systemic problems with the Army's MPT requirements determination procedures, and recommends solutions to identified deficiencies.

APPROACH

The BLACKHAWK Program review was divided into three major phases: literature review, data collection, and data analysis. Official Department of Defense (DOD) and Department of the Army (DA) publications concerning the MPT effort within the system acquisition process were reviewed; earlier and on-going studies were also researched. Specific UH-60A Program data was obtained from interviews with and draft and final MPT documentation prepared by Army materiel developers, combat developers, trainers, testers, manpower planners, personnel managers, and logisticians. Data was analyzed within the context of the MPT documents/events

identified in the Life Cycle System Management Model (LCSMM), as modified by the UH-60A Program acquisition strategy. Tools and techniques used to determine system MPT requirements were evaluated against those prescribed by the Army. The analysis paid particular attention to how much emphasis was placed on MPT issues in early requirement and contractual documents.

MAJOR FINDINGS

The UH-60A Program did not follow the "traditional" acquisition process outlined in the Army's Life Cycle System Management Model (LCSMM). The program bypassed the formal Concept and Demonstration/Validation phases, and began with a competitive Engineering Development phase. Acceleration of the acquisition process and contractor competition affected the early MPT requirements determination process.

Restrictions on communications and exchange of information between Army components and competing contractors inhibited estimates of definitive requirements until the winning contractor was selected at the end of the Engineering Development phase, some 5 years after program start. This circumstance reduced the time that manpower planners usually have to refine iterative estimates, and hindered the Army's ability to reliably predict quantitative maintenance manpower and training requirements.

Quantitative predictions were further hampered by two additional but related factors. First, manpower planners lacked

credible and complete Logistic Support Analysis (LSA) data needed to make quantitative calculations. This was primarily due to the fact that Sikorsky, the winning contractor, stopped LSA in the middle of the engineering development phase and did not resume the effort until the beginning of the Production and Deployment phase. The second contributory factor was that the Army lacked adequate analytical tools and definitive procedures which could be applied to the quantitative problem with either consistency or discipline.

Early qualitative manpower estimates held up rather well throughout the acquisition process due, in part, to the detailed system specifications and design criteria provided by the Army to contractors in requests for proposals (RFPs) and competitive development contracts. This definitive guidance, coupled with strong emphasis on system Reliability, Availability, and Maintainability (RAM), also resulted in an aircraft design which exhibited overall excellent soldier-machine interface characteristics.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

APPENDICES

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

A. BACKGROUND

Materiel Systems Acquisition programs are the subject of continuing analyses, reviews, and evaluations. The scope and extent of these program appraisals are consistent with the high cost of materiel systems over a life cycle, their impact on operational capability and effectiveness, and their demand on current and future resources. Specific guidelines have been established for development and acquisition of major systems by the Departments of Defense (DOD) and the Army (DA). The process is detailed and involves many management levels.

Despite the detail and depth of documentation and directives governing the acquisition process, problems regarding establishment of manpower requirements and their true cost have been prevalent. Sufficient numbers of properly trained personnel are essential to operate, maintain, and support current and future materiel systems. The improvements in these systems offered by new technology, a corresponding requirement for more highly skilled personnel, the steady upward trend in operating and support costs, and the projected reduced availability of the recruitable population demand a close and early look at manpower requirements for materiel systems under development to measure both supportability and affordability.

A number of previous studies, some of which are cited below, have highlighted problems associated with the determination of

Manpower, Personnel, and Training (MPT) requirements for new systems.

1. In December 1978, the Logistics Management Institute concluded a study of manpower planning for new weapon systems for the Assistant Secretary of Defense, Manpower, Reserve Affairs, and Logistics (ASD, MRA&L), complemented by seven case studies. Two of these concerned Army systems, i.e., TACFIRE and Patriot.[1] Significant findings from that study included the following:

- Most estimates of manpower requirements made during acquisition programs are too low.
- Operating and support concepts are likely to vary throughout the acquisition process, causing fluctuations in the estimates of manpower requirements.
- There is greater uncertainty associated with maintenance manning than with any other element of new weapon system manpower requirements.
- Estimates of new system manpower requirements frequently reflect program goals rather than unbiased assessments of manpower needs.
- Manpower goals or constraints established for new systems have addressed only the aggregate manning of the using unit, not total manpower or skill level requirements.
- Controlling training requirements can be as important as constraining manning levels.
- Operational test and evaluation conducted prior to DSARC III does not normally test the intermediate level of maintenance support.

2. In August 1980, Generals Walter T. Kerwin and George S. Blanchard prepared a discussion paper for the Army Chief of Staff

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[1]Betaque, Norman E., Jr., et al, Manpower Planning for New Weapon Systems, WN ML 801-1 Through WN ML 801-9. Logistics Management Institute. July - December 1978.

concerning the soldier-machine interface (SMI) problem.[2] In that report, Generals Kerwin and Blanchard stated,

> "The Army has made some progress in dealing with this problem. Many efforts are underway. However, these efforts, while representing steps in the right direction, are fragmented, based on reactions rather than vision, and, to a large extent, individually initiated. In our opinion, these efforts will fall short in coping with the extent of the problem in time to have an impact in the near term. Significant improvement will not occur quickly unless efforts are integrated, the personnel and doctrine people become more actively involved early in the materiel development process, and the Army addresses man/machine interface in its broadest sense and begins to think tactical system development in lieu of individual materiel development, individual people development and individual support development."

Specific observations presented in the report included:

- The Life Cycle System Management Model (LCSMM) must be disciplined concerning the manpower, personnel, training and logistics aspects of the process. Qualitative and Quantitative Personnel Requirements Information (QQPRI) and Basis of Issue Plans (BOIP) were singled out as examples.

- Careful consideration of MPT impacts must precede any variation in strategy which skips a phase of development for the purpose of achieving an early initial Operational Capability (IOC).

- Better utilization of and improvements in the QQPRI process are needed.

- MPT requirements must be better defined during concept evaluation.

- System development programs must recognize training constraints and employ sophisticated techniques to reduce training requirements.

- Human Factors Analysis and Engineering must become a mandated part of system development early in the cycle.

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[2]Blanchard, George S. & Kerwin, Walter T., Man/Machine Interface - A Growing Crisis, Army Top Problem Areas, Discussion Paper Number 2, August 1980.

- o PMs and TSMs must increase their emphasis on the MPT features of the Integrated Logistics Support (ILS) process.

- o The personnel community must become an active, rather than reactive, part of the acquisition process.

3. Some of the problems with the BOIP/QQPRI process identified by Generals Kerwin and Blanchard, were also discussed in a 7 January 1980 report by the Army Force Modernization Coordination Office (AFMCO).[3] In its examination, the BOIP/QQPRI Task Force reviewed the status of 76 new systems and found that of these 76, the BOIP/QQPRIs were late in 29 of the systems by an average of 19.5 months. Note: the task force considered current status of the primary item only, it did not consider associated equipment; Test, Measurement, and Diagnostic Equipment (TMDE); or training devices. Nor did the task force consider BOIP/QQPRI quality.

Regarding the impact of the late BOIP/QQPRI, the task force stated:

> "When the BOIP/QQPRI are not submitted on time, there is a high probability that the fielded system will be inadequately supported. At a low intensity of modernization there is some opportunity to offset late BOIP/QQPRI by shifting personnel and materiel resources to take advantage of other system delays and the general phase-in of equipment. However, the increased intensity of modernization during the next four to five years will not allow this opportunity. In short, twenty-nine of the Army Modernization Information Memorandum (AMIM) systems to be fielded in the next three years may not be adequately supported in the field."

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[3]HQDA, Office of the Chief of Staff, <u>BOIP/QQPRI Task Force Report</u>, 9 January 1980.

The report goes on to say:

> "There are many reasons for the number of late BOIP/QQPRI in the set of systems the task force examined. Part of the reason is a failure to adequately discipline the system. In many cases it is due to inadequate priorities being assigned to the extreme importance and value of the system with a consequent underresourcing of manpower at all levels. Above all, there exists no mechanism to centrally manage and police the preparation and submission of the BOIP/QQPRI."

4. A previous ISI study conducted for ARI,[4] identified and analyzed the MPT information required to be generated by the Army's LCSMM process. That study concluded that, if properly prepared in the sequence stipulated, MPT information should be adequate to meet LCSMM milestone goals. However, it also confirmed findings of other studies that the information generated in preparation for recent Army and Defense System Acquisition Review Council (ASARC/DSARC) reviews had been inadequate in some quality and timeliness of MPT planning and programming during the LCSMM process.

5. In January 1981, amid growing concern that its materiel systems are becoming too complex, HQDA directed U.S. Army Training and Doctrine Command (TRADOC) to lead an internal Army study to assess the impact of the SMI on total systems management and how the Army can better match men, skills, and machines.[5] The study was designed to either validate or recommend revision

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[4]Rhode, Alfred S., et al, Manpower, Personnel and Training Requirements for Materiel System Acquisition, ARI, February 1980.

[5]HQDA, Soldier-Machine Interface Requirements (Complexity) Study, January 1982.

to the existing materiel system acquisition procedures to insure that the Army pursues the best possible course to match men, skills, and machines during the next decade.

To accomplish the task, the study addressed in a very broad sense 30 different systems representative of most system types in various mission areas. Further, for each system, the study addressed all system-specific tasks associated with the immediate soldier-machine interface at operator; maintainer, and repairer (through GS) levels.

Since the objectives of that complexity study were similar to those of this effort, coordination was established with the complexity study team and information exchanged.

B. PURPOSE

This is one of four historical case studies dealing with Manpower, Personnel, and Training problems associated with the Army's acquisition of the following materiel systems:

- o AN/TYC-39 Message Switch & AN/TTC-39 Circuit Switch (AN/TTC-39 Program)
- o Multiple Launch Rocket System (MLRS)
- o UH-60A Helicopter (BLACKHAWK)
- o AN/TPQ-36 Mortar Locating Radar & AN/TPQ-37 Artillery Locating Radar (FIREFINDER)

Each case study examines the Army's ability to comply with its stated MPT requirements determination procedures during the development of specific systems, and assesses the timeliness and quality of the MPT products. A fifth report, which accompanies

these case studies, analyzes the four systems, identifying similarities and differences in the acquisition process and drawing comparisons where appropriate. It is stressed that the principal objective is to examine when and how well MPT requirements were developed and expressed, particularly during the early stages of system development.

C. APPROACH

1. System Selection

The systems selected for study represent a cross section of Army combat development mission areas, e.g., Fire Support (MLRS), Aviation (BLACKHAWK), Tactical Surveillance, Reconnaissance, and Target Acquisition (FIREFINDER), and Communications (AN/TTC-39 Program). Each of the systems selected has a high development priority and is well along in the acquisition process, thus permitting a more comprehensive examination of actual MPT events and documentation. Availability of US Army Materiel Development and Readiness Command (DARCOM) Project Managers (PM) and US Army Training and Doctrine Command (TRADOC) System Managers (TSM) to interact with study team members also influenced the choice of systems.

2. Scope

For each system case study, actual MPT events/documents and organizational elements responsible for their accomplishment are identified down to subordinate elements within DARCOM and the subordinate proponent school level within TRADOC.

Occurrence of events are portrayed in time relative to the sequence called for in the Life Cycle Systems Management Model (LCSMM).[6] The May 1975 LCSMM was used as a baseline although some early acquisition stages in the systems examined began prior to that date. Tools and techniques used to generate MPT requirements are described and their value assessed. Qualitative and quantitative changes in MPT requirements are tracked, beginning with the initial establishment of system need and continuing through the latest completed event in the system's acquisition process. Reasons for such changes are also stated in those instances where data availability permitted such a determination to be made.

Where possible, the adequacy and timeliness of MPT information are assessed to determine whether ASARC; DSARC; Planning, Programming, and Budgeting System (PPBS); and fielding needs were met. If not, reasons for such deficiencies and their impact are stated.

The fifth report identifies and analyzes differences in when and how well MPT requirements were developed and expressed. The reasons for and impact, if any, of the identified differences are assessed to identify particularly effective/ineffective approaches to generation of MPT data; common problems and lessons learned are also highlighted. Recommendations for correction of identified deficiencies are made, taking into account significant

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[6]HQDA, Pamphlet No. 11-25, Life Cycle System Management Model for Army Systems, May 1975.

efforts either recently completed or currently underway by the Department of Defense (DOD) and the Army to improve the MPT requirements determination process, e.g., Carlucci initiatives; changes in Army policies and procedures for processing QQPRI and BOIP (AR 70-2); and staffing a proposed new Military Standard for Weapon System and Equipment Support Analysis (MIL-STD-1388A).

The research effort was divided into three major phases: Literature Review; Data Collection; and Data Processing and Analysis.

3. Literature Review

The study effort began with a review of literature pertinent to the development and expression of MPT requirements for new materiel systems. It included an examination of policies and procedures promulgated by DOD; Headquarters, Department of the Army (HQDA); Headquarters, DARCOM; and Headquarters, TRADOC. Related study efforts and research reports such as those mentioned in paragraph A, supra, were also reviewed for background, ideas for data gathering and analysis methods, and to avoid unnecessary overlap and duplication of earlier efforts. Major policy and procedural document sources examined during this review are cited in Appendix A.

4. Data Collection

The evolution of MPT information for the UH-60A Program in response to materiel development policies and procedures, including the LCSMM and the Integrated Logistics Support

Management Model (ILSMM) processes, was tracked through each phase of the acquisition process. Data was gathered through examination of draft and final MPT documents and face-to-face interviews with Subject Matter Experts (SME) representing combat/materiel developers, trainers, testers, manpower/personnel planners, and personnel managers. Data cutoff was 31 May 1982. Specific organizational elements contacted during the collection effort are identified in Appendix B. The major MPT source documents are listed in Appendix C.

5. Analysis

Information collected was cataloged and analyzed across acquisition milestones, measured against MPT data requirements in the LCSMM, and where appropriate, compared with like or similar systems; basic criteria for analysis were timeliness and adequacy of data relative to LCSMM and Army regulatory standards. The criteria were applied in examining the following major issues.

- o Tools, techniques, and standards used to compute and express MPT requirements and tradeoffs.
- o MPT requirements documentation and flow of information to decision makers.
- o The acquisition process itself, in terms of MPT requirements determination.

II. SYSTEM SUMMARY

A. SYSTEM DESCRIPTION

The UH-60A (BLACKHAWK)[7] is a twin engine utility helicopter developed to replace the Army's single engine UH-1 "Huey" for air assault, short-range combat/combat support/combat service support equipment and troop movement, air cavalry, and aeromedical evacuation missions. The BLACKHAWK is designed to carry more than twice the payload of the UH-1 and to transport a combat equipped 11-man squad 42 knots faster in all weather and altitude conditions. Basic characteristics of the BLACKHAWK are summarized in Figure II-1.

The basic UH-60A flight crew, like the crew for the UH-1, consists of a pilot, co-pilot, and a crewchief/gunner; in a combat environment, a gunner may augment the crew as a fourth member. A medical corpsman is a standard fourth crewmember in all air ambulance units.

The primary UH-60A unit is the Combat Support Aviation Company (CSAC) which can be either a separate unit or a subordinate element of an aviation battalion. Each Army division has an organic aviation battalion with a variable number of CSACs, depending on the type division. In most CSACs, 15 UH-60As will replace 23 UH-1s.

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[7]During early stages of development, the BLACKHAWK was referred to as the Utility Tactical Aircraft System (UTTAS). For simplicity, it will be referred to as UH-60A throughout this report.

UH-60A CHARACTERISTICS

GROSS WEIGHT:	16,250 pounds
SPEED:	145 knots
ENDURANCE:	2.3 hours
VERTICAL RATE OF CLIMB:	635 ft/min at 4000 ft/95^{o}F
ARMAMENT:	two 7.62mm machine-guns
PAYLOAD:	11 troops 2640lbs at 4000 ft/95^{o}F/max vertical climb

FIGURE II-1

Air cavalry and aeromedical units are the other principal types of Army units selected to received UH-60As as replacements for UH-1s. Seven UH-60s will replace eight UH-1s in air cavalry troops, and the replacement ratio in aeromedical units will be one for one.

B. MAJOR ACQUISITION MILESTONES

The first major milestone in the acquisition of the BLACKHAWK was the Defense System Acquisition Review Council I and II (DSARC I/II) decision authorizing the Army to proceed with Full-Scale Engineering Development (FSED), in May 1971.

On the basis of that decision, the General Electric Company was awarded a contract for development of the engine in March 1972. Competitive contracts for develpment of the airframe were awarded to the Boeing-Vertol and Sikorsky Companies in August 1972.

In November 1976, some 51 months after the airframe contract was awarded and following Government Competitive Tests (GCT), a DSARC III decision authorized the Army to proceed into the Production and Deployment Phase.

The Army type classified the airframe as standard and awarded a maturation and initial production contract to the Sikorsky Company in December 1976. By October 1979, 19 aircraft had been delivered to the Army, and an Army System Acquisition Review Council (ASARC IIIA) decision approved continued produc-

tion. Initial Operational Capability (IOC) was achieved by the 101st Airborne Division (Air Assault) at Fort Campbell, KY, in November 1979. Figure II-2 illustrates the BLACKHAWK acquisition milestones.

UH-60A MAJOR ACQUISITION MILESTONES

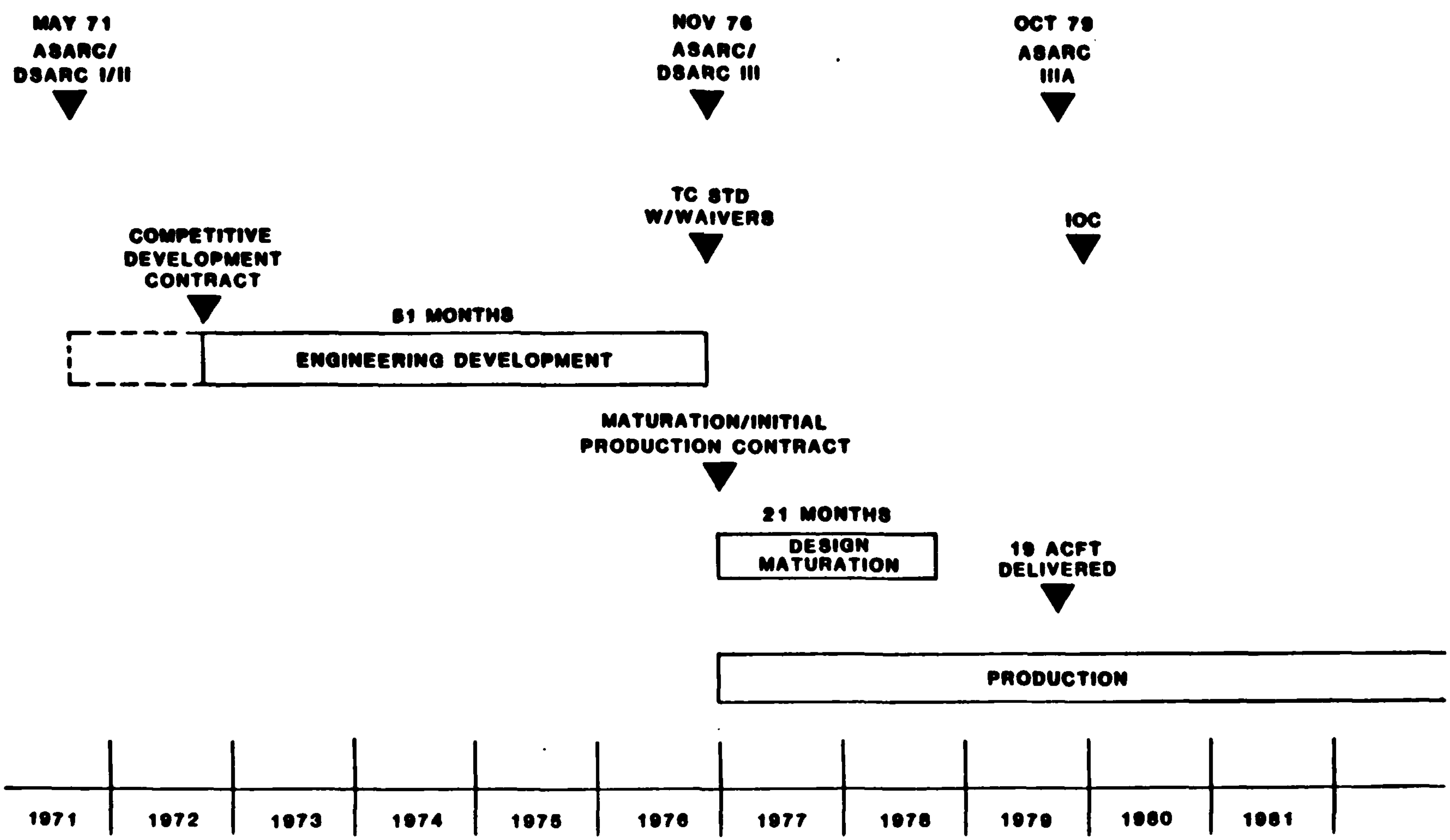

FIGURE II-2

III. DETERMINATION OF MPT REQUIREMENTS - DISCUSSION

A. INTRODUCTION

The discussion in this Section is based on examination of available MPT data gathered through review of documents and interviews with Subject Matter Experts (SMEs). The discussion is organized chronologically to show progressive steps and changes in information as the UH-60A (BLACKHAWK) Program proceeded through the various phases of the acquisition process. Figures, tables, and summaries are used to provide the reader with a more complete understanding of the inter-relationship of events and the data generated by them.

As mentioned in Section I, MPT events are portrayed in time relative to the sequence called for in the Life Cycle System Management Model (LCSMM). The LCSMM, promulgated by DA PAM 11-25, May 1975, depicts the process by which Army materiel systems are initiated, validated, developed, deployed, supported, and modified. It is divided into four major segments corresponding to the four acquisition phases, i.e., Conceptual, Validation, Full Scale Engineering Development, and Production and Deployment.

It must be remembered that the model is not rigid. It is possible for many of the LCSMM events to be bypassed. Only events deemed pertinent and necessary for the development of the particular system are accomplished. In the development of some

systems, entire phases may be bypassed; such was the case with the UH-60A Program which skipped the Conceptual and Validation phases.

B. CONCEPTUAL PHASE

In this phase, the technical, military and economic basis for proposed systems are established and concept formulation initiated through pertinent studies. Critical issues and logistical support problems and actions are identified for investigation and resolution in subsequent phases to minimize future development risks. This phase is a highly interactive process with activities performed simultaneously and/or sequentially. No specific period of time in months or years is prescribed for the Conceptual Phase since the phase length is determined by the characteristics and status of the operational and technical factors making up the proposed program, the urgency of meeting the predicted operational threat, or environment and resource constraints. For systems that require DSARC approval, the phase ends at Milestone I with Event 14, DSARC I/DCP I approval and Secretary of Defense (SECDEF) authority to proceed to the Validation Phase.[8] Figure III-1 identifies the major LCSMM events in the Conceptual Phase. Since publication of DA PAM 11-25, the upfront requirements have become more formalized. A Milestone 0 was added and an approved Mission Element Need

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[8]LCSMM, page 2.

CONCEPT PHASE

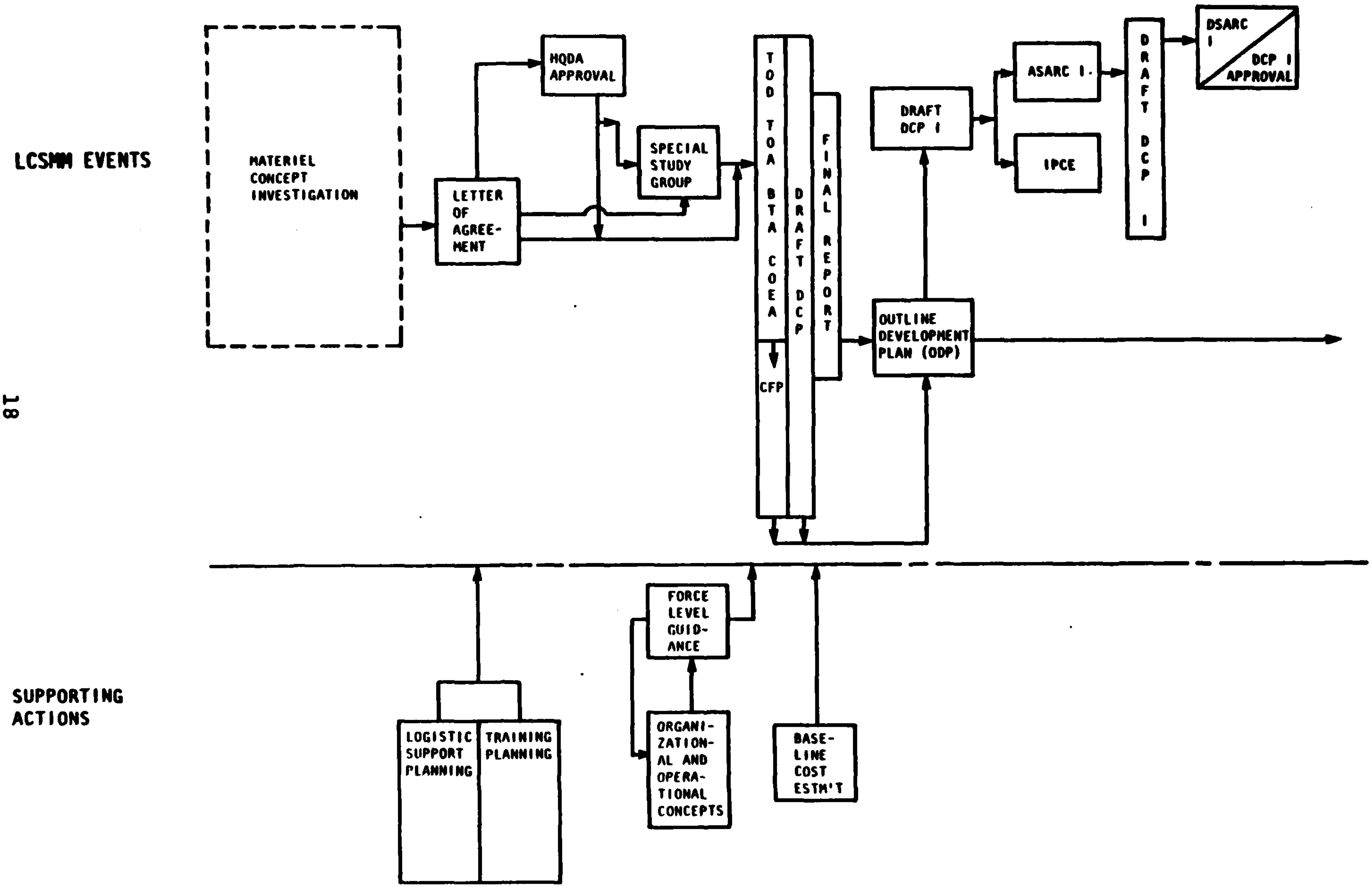

FIGURE III-1

Statement (MENS) was established as the authority to proceed into the Conceptual Phase for new major system acquisitions. Recent changes in the acquisition process substituted a Justification for Major System New Starts (JMSNS) for the MENS, and required it to be submitted not later than the Program Objective Memorandum (POM) submission in which funding is to be included.

While the UH-60A Program did not formally proceed through the Conceptual Phase, the military, technical and economic bases for the system had been examined in some detail before the first formal milestone (DSARC I/II) in May 1971. However, this study effort was unable to find evidence in the form of specific documentation concerning the degree of consideration given to MPT issues prior to DSARC I/II.

C. VALIDATION PHASE

This phase consists of those steps required to verify preliminary design and engineering, accomplish necessary planning, analyze trade-off proposals, resolve or minimize logisitics problems identified during the conceptual phase, prepare a formal requirements document, and validate a concept for full-scale development. The validation process may be conducted by competitive or sole source contractors or by in-house laboratories. Advanced development prototypes (brassboard) should be used and tested (Development Test/Operational Test (DT/OT I)) during the validation phase to provide data to estimate the prospective system's military utility, cost, environmental impact, safety

(noise level, radiation and toxicological effects), human engineering, operational effectiveness and suitability to include surety and/or technological factors, and to refine configuration prior to entering full-scale development.[9] Figure III-2 illustrates major events identified in the LCSMM for the validation phase.

The UH-60A Program had no formal Validation/Demonstration Phase. The MPT/MPT related events which normally would have taken place in this phase were combined with similar events in the next phase. The Program was approved for entry into the Full-Scale Development Phase following DSARC I/II in May 1971.

D. FULL SCALE ENGINEERING DEVELOPMENT (FSED) PHASE

During this phase, the system, including all items for its support, is fully developed and engineered, fabricated, tested (DT/OT II), and a decision is made as to whether the item is ready for production. Concurrently, nonmateriel aspects, e.g., MPT, required to deploy an integrated system are developed, refined, and finalized.[10]

Figure III-3 illustrates system and MPT related events identified in the LCSMM for the Engineering Development Phase versus those actually accomplished according to available data for the

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[9] LCSMM, page 2.

[10] LCSMM, page 2.

DEMONSTRATION/VALIDATION PHASE

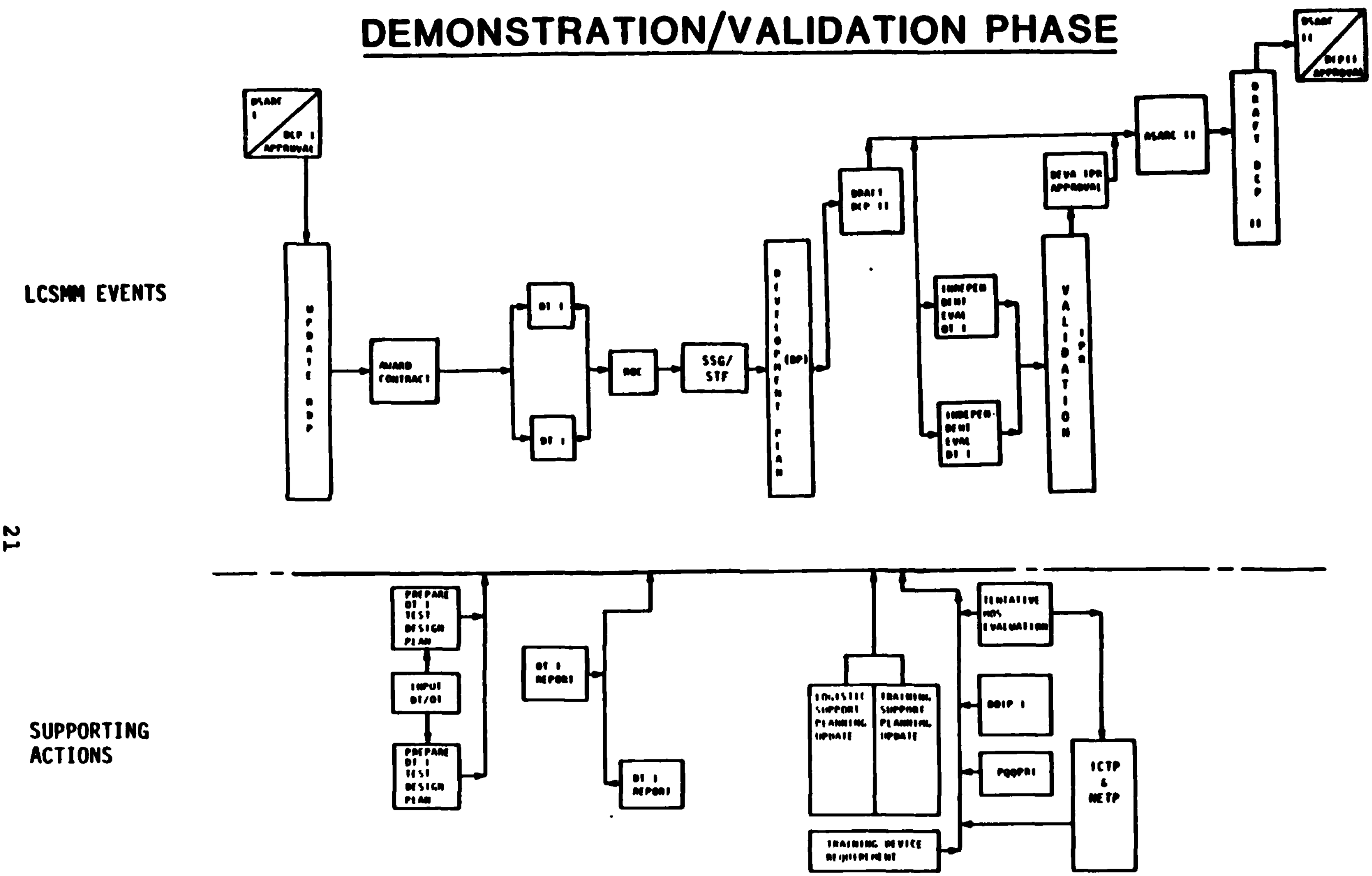

FIGURE III-2

FULL SCALE ENGINEERING DEVELOPMENT PHASE

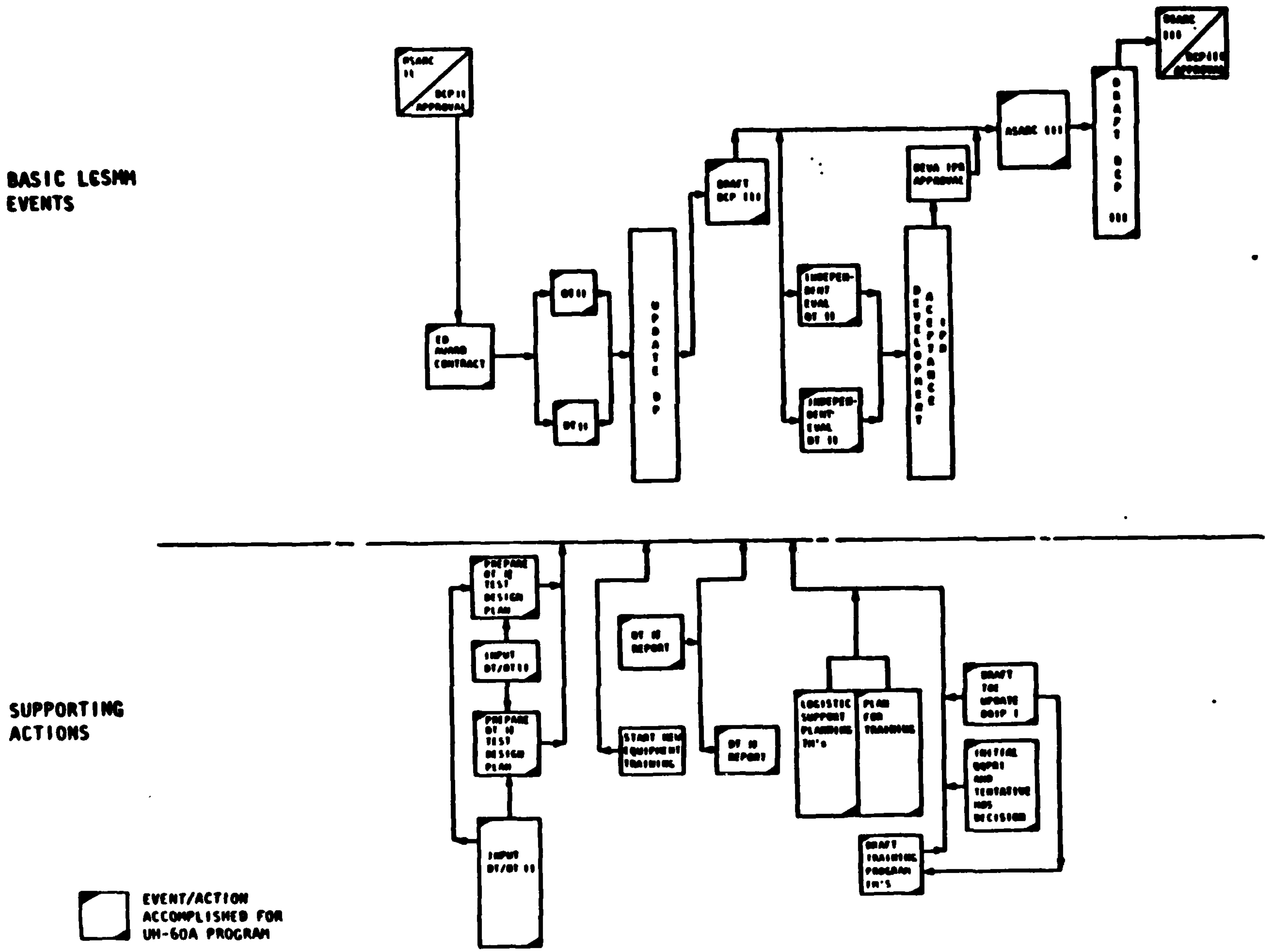

FIGURE III-3

UH-60A Program. Significant MPT and MPT related events during this phase are discussed below. It should be noted that design and engineering development of the UH-60A airframe during this phase was performed competitively by two companies -- Boeing-Vertol and Sikorsky. In a "normal" acquisition program such competition would usually take place in the Validation/Demonstration Phase.

1. Requirement Document - Materiel Need (MN)

The MN contained relatively well defined statements concerning MPT requirements/constraints. These are summarized in Figure III-4.

Since the UH-60A was developed to perform the same basic mission as the UH-1, the Army was able to access considerable information, gained through years of experience with the UH-1, in projecting the UH-60A requirements. Early UH-60A system documents, beginning with the MN, indicate that the Army took advantage of lessons learned from the UH-1; the high priority placed on maintainability and reliability in the MN illustrates that point.

The MN anticipated an eventual reduction in overall utility helicopter manpower requirements due to the need for fewer UH-60As in air assault units. The MN also predicted that maintenance manpower requirements would decrease because of design requirements for simplified maintenance and longer component life.

UH-60A MATERIEL NEED

(Feb 1972 - Updated Nov 1973)

MPT RELATED STATEMENTS

CREW SIZE

- Peacetime 3
- Wartime 4 (Door Gunner Augmentation)

LIFT CAPABILITY

- 11 Combat Equipped Troops or Equivalent Load

OPERATIONAL RELIABILITY

- .988909

OPERATIONAL AVAILABILITY

- .82

OPERATOR SKILLS

- Same as UH-1

MAINTENANCE SKILLS

- Qualitative-Should not Exceed UH-1 Except for Advanced Avionics
- Quantitative-Should Decrease Due to Fewer Acft/Unit & Design Requirements for Simplified Maintenance

OPERATIONAL CONCEPT

- Infantry Squad Carrier-Primarily in Forward Areas-Assault and Resupply

MAINTENANCE CONCEPT (Nov 73 Update)

- Established 3 Level Maintenance Concept (AVUM/AVIM/DEPOT)

TRAINING

- Envisioned Little or no Change From Current UH-1 Requirements

***PRIORITY OF CHARACTERISTICS**

- Performance
- Maintainability & Reliability
- Air Transportability
- Vulnerability

*Human Engineering Integral to all Characteristics & Given Special Emphasis in all Development Phases

FIGURE III-4

2. Request for Proposal (RFP)

The Army translated MPT/HF related requirements from the MN into detailed quantitative and qualitative specifications in the RFP issued in January 1972. These criteria are summarized below, and illustrate the concern given to Reliability, Availability, and Maintainability (RAM). Without specifying how, the Army also called upon contractors to integrate Human Factors Engineering (HFE) into system design. Additionally, the RFP required the contractors to provide specific plans for assessing personnel, training, and training device requirements for the UH-60A.

a. Operational/Organizational Concepts

The RFP defined roles for the UH-60A according to various conflict intensities (Low-Mid-High), and identified the primary UH-60A unit as being the Assault Helicopter Company, which has since been renamed the Combat Support Aviation Company. It envisioned employment of the UH-60A singly, in sections, platoons, companies, or battalions within divisions and corps.

b. Maintenance Concept

The original RFP called for maintenance of the UH-60A to be performed at the traditional four levels--organizational (OL), direct support (DS), general support (GS), and depot. In the only substantive change to the original RFP requirements, the maintenance concept for aviation systems was changed in 1974 to the following three levels.

1) Aviation Unit Maintenance (AVUM)

- o Includes 100 percent of OL plus 60 percent of DS
- o Organic to operating unit
- o All preventive maintenance and limited corrective maintenance
- o Removal/installation with limited skills, tools and maximum use of modular quick disconnect design
- o Highly mobile test/diagnostic equipment

2) Aviation Intermedite Maintenance (AVIM)

- o Includes 40 percent of DS and 40 percent of GS
- o Repair end items, secondary items, and designated modules
- o Troubleshoot, adjust, align and calibrate
- o Operate direct exchange service
- o Evacuate designated items to depot

3) Depot Maintenance

- o Includes 60 percent of GS and 100 percent of depot
- o Increased workload under this concept
- o Major user of piece parts

These changes occurred fairly early in the development process, and did not appear to have caused any significant problems in the early determination of MPT requirements.

c. Reliability, Availability, Maintainability (RAM)

Figure III-5 summarizes RAM criteria specified in the RFP, and illustrates the significant level of early detail provided to the contractors.

The RFP also cited a number of specific maintenance engineering objectives, some of which are listed below. These objectives, along with the RAM criteria, influenced determination of MPT requirements.

- o Reduce amount/frequency of maintenance required
- o Minimize requirements for special skills, tools, and support equipment
- o Reduce volume & improve quality of maintenance publications
- o Reduce maintenance facility requirements
- o Reduce supply support required
- o Use maintenance personnel skills and knowledge to augment supply control
- o Improve maintenance career management
- o Reduce life cycle costs

d. Human Factors Engineering (HFE)

The RFP called for integration of human performance into system design to meet the following objectives.

- o Ensure effective, efficient and reliable man-equipment combination under use conditions
- o Ensure that human tasks involved in operating, maintaining, and supplying UH-60A do not exceed capabilities of crew and support activities

UH-60 REQUEST FOR PROPOSAL

(December 1971)

RELIABILITY

• MISSION	.986909 For 1-Hour Mission
• SAFETY	.999952 For 1-Hour Mission
• MTBF	4 Flight Hours
• MTBR	1500 Flight Hours (Aircraft Dynamic Components)

AVAILABILITY*

• Inherent	0.97
• Achieved	0.92

*Based on Flying Hour Program of 60 Hours per Acft in a 730 Calendar Month

MAINTAINABILITY (QUANTITATIVE)

- MTTR – 1.3 Hours With NMT
  2 Men/Task and 50% of Tasks
  Requiring 1 Man (AVUM). NMT
  3 Men/Task (AVIM)
- MTBM – Preventive/Corrective
  1.65 Flight Hours
  Periodic Inspection
  300 Flight Hours
  Daily Inspection
  3 Flight Hours
- CMMH/FLT HR – 6.7 All Levels
  4.2 AVUM/AVIM
- ISMMH/FLT HR – 1.0
- REOC – 0.2 Hours With NMT 2 Men
- MCC – Armament 0.5 With NMT 2 Men
  Aeromedical 0.3 With NMT 2 Men
  Troop Seats 0.3 With NMT 2 Men

MAINTAINABILITY (QUALITATIVE)

- Skill Level – Aircraft Maintenance School Graduate With 6-Months on-job Experience
- Maximum Accessibility
- Minimum Adjustment at AVUM
- Direct Reading Indicators/Gauges
- Common/Standard Test Equipment
- Minimum Steps for Part Removal/Replacement
- Minimum Personnel/Skills/Tools for Field Assembly/Adjustment
- Positive Locking Quick Disconnects for Electrical/Hydraulic/Fuel/Pneumatic/Avionic Systems

FIGURE III-5

Each responding contractor was required to submit an HFE program plan to include the following elements.

- o Method of integrating HFE into design effort
- o Method of deriving training requirements/devices from HFE analysis
- o Provision for test/evaluation of HFE design inputs

e. Personnel and Training

Contractors were called upon to submit plans for determining support personnel requirements and factory training needs, and for identifying proposed training devices. The RFP also informed contractors that personnel, training and training device requirements analyses would have to be performed during both the development and production phases.

3. Contractor Proposals

The proposals submitted by Sikorsky and Boeing for the competitive phase (FSED) were responsive to RFP requirements in the MPT and HFE areas. Sikorsky, the eventual winning contractor, provided a detailed plan for integrating HFE into system design, and outlined efforts to ensure that RAM would be given high priority in design and engineering development. Sikorsky described its Maintenance Engineering Analysis (MEA) methodology, and identified products to be derived from that effort, to include personnel and training requirements. Factory training objectives and specific courses were proposed, along with equipment publications to be developed.

4. Government Competitive Tests (GCT)

Government competitive testing was conducted in two phases--Development Test (DT) II and Operational Test (OT) II. Both phases compared prototype aircraft developed by the two competing contractors and the UH-1. Contractor testing which preceded GCT was more extensive than required by the government test design plan. The competitive nature of the program and the Army's emphasis on RAM goals appeared to motivate the contractors to use extra flight test hours to improve RAM characteristics. GCT evaluators observed that the design maturity of prototypes exceeded expectations.

The DT phase of GCT was conducted in two parts. In the first part, the Army Aircraft Development Test Activity (ADTA), Test and Evaluation Command (TECOM) tested two prototypes from each contractor at Ft. Rucker, AL from 19 March to 16 June 1976. Each competing prototype flew approximately 300 hours. Maintenance personnel for this first part of DT were from the 101st Airborne Division (Air Assault); the same personnel participated in OT II at Ft. Campbell, KY. The following MPT/HFE related issues/ questions were addressed during this part of DT.

- o Do the measured HFE and safety aspects of the system show a potential for significant improvement in crew efficiency and reduction in aircraft and personnel attrition?
- o Do the measured RAM characteristics of the system indicate that the Army would benefit significantly in terms of cost and personnel resources through replacing current operational helicopters with the new system?

The second part of DT was conducted by the Army Aviation Engineering Flight Activity (AEFA) at Edwards AFB, CA from 19 March to 18 September 1976. Each contractor's prototype underwent extensive engineering flight tests which measured performance and handling qualities.

An independent evaluation of DT test results by the US Army Materiel Systems Analysis Activity (AMSAA) noted few HFE/Safety deficiencies, and regarded those that were found to be easy to correct. A specific favorable assessment was made concerning HFE aspects of maintainability. The evaluation highlighted the fact that even under rushed and less-than-optimum conditions, maintenance operations proceeded without any degradation to reliability, safety, or operational flexibility. Maintenance errors were considered negligible. The AMSAA report concluded that man-machine design characteristics reduced manpower resource demands in terms of numbers of personnel, diversity of skills, and training requirements.

The OT phase of GCT was conducted by selected elements of the 101st Airborne Division (Air Assault) from 21 June to September 1976, and was independently evaluated by the Army Operational Test and Evaluation Agency (OTEA). As in DT, two prototypes from each contractor were tested; however, four UH-1 aircraft were also tested to provide data for comparison. The prototypes flew a total of 514 hours and the UH-1 aircraft flew 540 hours. There were 752 controlled mission events during the test.

The small number of prototypes available was cited as a test limitation with the explanation that data from so few aircraft could not offer a sound basis for estimating total projected organizational capabilities under operational conditions. Another test limitation cited by OTEA was that the combined DT II/OT II flight hours were insufficient to provide a full assessment of all RAM issues. Nevertheless, it was felt that enough was learned to permit conclusions to be drawn.

OTEA indicated that both candidates exhibited HFE design characteristics which were superior to the UH-1. Major HFE areas identified for needed improvement in the Sikorsky prototype were noise levels in the crew and passenger compartments; forward visibility; and air circulation.

As far as MPT was concerned, OTEA estimated that "typical" Army personnel should be able to successfully operate and maintain either candidate system; and that training of pilots, maintenance personnel, and user troops would be no more difficult than for the UH-1.

5. Source Selection Evaluation Board (SSEB)

The SSEB evaluated the competing contractors on the basis of their production proposals, contractors' test results, and results of the GCT (DT II/OT II). Evaluation criteria and scoring weights are shown in Figure III-6. Human factors engineering and MPT were not significantly weighed; however, some

UH-60A
SSEB EVALUATION

TECHNICAL		**47.5%**
Design Integrity	35%	
Technical Capability	65%	
Maturity Development	not scored	
Producibility	not scored	
OPERATIONAL SUITABILITY		**47.5%**
Mission Performance	45%	
*Maintainability	27%	
Transportability	23%	
Training, Personnel, & Organization	5%	
LOGISTICS		**5%**
ILS	100%	
GCT SPT PERFORMANCE	not scored	

*INCLUDED CONSIDERATION OF HFE ASPECTS OF MAINTENANCE

FIGURE III-6

judgments about HFE/MPT aspects were made as part of the operational suitability and logistics evaluations. For example, Maintenance Engineering Analysis (MEA) and the resultant products, including maintenance manpower and training requirements, were assessed as part of the overall Integrated Logistic Support (ILS) evaluation. Maintainability evaluation for determination of operational suitability included an examination of HFE aspects of maintenance. The SSEB found both candidates satisfactory and about equal in the MPT/HFE areas.

6. Early Contractor Deliverables

The primary MPT deliverable was a Personnel, Training, and Training Device Analysis Report (PTTDAR). Three iterations of this report were submitted, two during the FSED phase (November 1974 and September 1976) and a final report early in Production phase (April 1977). Each report provided Qualitative and Quantitative Personnel Requirement Information (QQPRI) input, proposed factory training and Army resident training courses, and made training device recommendations.

The QQPRI input section of the report identified maintenance tasks for each major system component by Military Occupational Specialty (MOS). It also placed each listed maintenance task at either the AVUM or AVIM level. Depot skill specialty requirements and specific tasks were not identified since that information was to be a product of MEA in the production phase. The PTTDARs referred to attachments which listed the number of

maintenance manhours required for each component; however, the attachments could not be located. The data provided in these PTTDARs were used by the materiel developer to initiate the UH-60A QQPRI.

The factory training plan identified courses, training aids, and instructor materials required for both the FSED and production phases.

The resident training plan consisted of the contractor's recommendations for training concepts, training aids, schedules for development and delivery of materials to Army resident schools, and plans for updating materials. In the PTTDARs submitted during the competitive phase (FSED), Sikorsky commented that the resident training recommendations were limited in depth and detail because of the competitive nature of the program. Sikorsky observed that the contractor was prevented from establishing normal communications with Army resident schools, and that the competition limited the free flow of information among the various Integrated Logistics Support Management Team (ILSMT) members.

The training device recommendations were contained in the September 1976 PTTDAR. It identified and described some 24 computer assisted instruction trainers, composite multi-task trainers, and subsystem multi-task trainers. The recommendations further suggested appropriate MOSs for training on each device.

Maintenance manuals and other equipment publications were early deliverables required for GCT, but these early publications were not available for review. The consensus among representatives of the Army acquisition and training communities was that the publications were adequate; some of the maintenance manuals were described as being innovative and easier to use and understand than those for the UH-1.

7. <u>QQPRI and BOIP</u>

a. General.

The QQPRI and BOIP are iterative documents that provide manpower and training planners the earliest and most current information concerning the numbers and qualifications of personnel required to operate, support, and maintain a materiel system under development. For the majority of acquisition programs, input to both documents comes from a variety of organizational sources within the materiel development (DARCOM) and combat development (TRADOC) communities. A substantial amount Of basic data in both documents is derived from Logistic Support Analysis (LSA). The materiel developer, e.g., AVRADCOM in the case of the UH-60A Program, initiates both the BOIP and QQPRI processes by preparing BOIP Feeder Data (BOIPFD). The BOIPFD lists all principal and associated items of equipment, to include Test, Measurement, and Diagnostic Equipment (TMDE) required to support the new system. The materiel developer also concurrently prepares a proposed QQPRI which lists skills, tasks, and knowledge

required to operate and support the new item and its Associated Items of Support Equipment (AIOSE), and estimates of time required to maintain it. Both the BOIPFD and proposed QQPRI are forwarded by the materiel developer through DARCOM channels to TRADOC.

The materiel developer's proposed QQPRI is refined at TRADOC by adding the training, support and doctrinal implications of the new system. Using data from both the QQPRI and BOIPFD along with the O&O concept, a TRADOC proponent school, e.g., US Army Infantry School in the case of the UH-60A Program, develops the BOIP. The BOIP is a planning document which predicts organizational quantitative equipment and personnel requirements for a system.

Following TRADOC's refinement of the QQPRI and development of the BOIP, both documents are staffed at the Soldier Support Center-National Capital Region (SSC-NCR) and HQDA to determine if the system falls within manpower constraints; reflects the appropriate Military Occupational Specialty (MOS)/Special Skill Identifier (SSI)/Additional Skill Identifier (ASI); meets Standard of Grade Authorization (SGA); has a feasible grade structure; and can be supported by Army recruiting and training capabilities. As the system proceeds through the development process, QQPRI and BOIP must be updated to reflect the latest outputs from the LSA and other events which indirectly feed the BOIP and QQPRI. These two documents, among others, are also prerequisites for the decision to type classify new Army materiel as standard.

b. UH-60A QQPRI

A "so-called" Final QQPRI (FQQPRI) was initiated by the materiel developer in July 1976 while the helicopter was still undergoing government competitive testing. It reaffirmed that the direct operators would be the pilot, co-pilot, and crew chief/gunner; that air ambulance crews would be augmented with a medical corpsman; and that a full-time gunner would augment, the crew in wartime.

In addition to the three basic crew members, the FQQPRI also identified some 15 other positions by title and suggested current, revised, or new MOSs required to maintain the helicopter at AVUM and AVIM levels. An amended FQQPRI prepared in November 1976, immediately following GCT, made no changes in the FQQPRI qualitative estimates. Table III-1 compares FQQPRI qualitative manpower proposals with those offered by the winning contractor (Sikorsky) in PTTDARS submitted prior to and after preparation of the FQQPRI by the materiel developer.

For each candidate system and based on partial Maintenance Engineering Analyses (MEA), the FQQPRI reported the cumulative direct maintenance manhours per 1000 flight hours for each MOS at the AVUM and AVIM levels of maintenance. The FQQPRI pointed out that the manhour information would be updated by RAM data being gathered during GCT.

As will be demonstrated later in this report, the maintenance manhours listed in the QQPRI are important inputs to the

TABLE III-1

UH-60A Qualitative Manpower Estimates

Position	Speciality/ MOS	PTTDAR Nov 74		FQQPRI Jul/Nov 76		PTTDAR Sep 76/Apr 77	
		AVUM	AVIM	AVUM	AVIM	AVUM	AVIM
Rotary Wing Aviator	15A/100B			X	X		
Maintenance Test Pilot	71A/100BRU			X	X		
Helicopter Repairer (Rpr)/ Crew Chief	67 ( )	X	X	X	X	X	X
Aircraft (Acft) Quality Control Supervisor	67 W	X	X	X	X	X	X
Acft Maintenance Senior Sergeant	67 Z			X	X		
Acft Powerplant Rpr	68 B	X	X	X	X	X	X
Acft Powertrain Rpr*	68 D	X	X	X	X	X	X
Acft Rotor Rpr*	68 E	X	X			X	X
Act Structural Rpr*	68 G	X	X	X	X	X	
Acft Pneudraulics Rpr	68 H	X	X	X	X	X	X
Avionic Mechanic	35 K	X		X		X	X
Avionic Communications Equipment Rpr	35 L				X		
Avionic Navigation Equipment Rpr**	35 M				X		
Avionic Flight Control Equipment Rpr**	35 N	X	X	X	X		X

* MOS 68E sugsequently eliminated and tasks divided between MOS 68D and MOS 68G.

** MOS 35N subsequently eliminated and tasks assumed by MOS 35M.

process by which the combat developer (TRADOC) determines quantitative manpower requirements for a new system. This data is usually produced by the Logistics Support Analysis (LSA) and extracted from LSA Records (LSAR).

In the case of the UH-60A, LSAR estimates of maintenance man-hours have been periodically provided to the materiel developer as part of the LSA process conducted by Sikorsky. However, it is important to make two points about the early estimates emanating from that process. First, when the competitive engineering development contract was awarded in early 1972, the LSA process as we know it today was not required. Implementation of MIL STD 1388 (LSA) began in 1974. Sikorsky cooperated with the Army in using the UH-60A as a test system in converting LSA procedures done under the Standard Integrated Support Management System (SISMS), and referred to as MEA, to the more demanding and automated procedures called for in MIL STD 1388. That transitioning process caused some degradation to very early MEA data. Secondly, Sikorsky's LSA effort was stopped completely in early 1976 following Congressional reduction of funds for prototype development. The Army advised the competing contractors to concentrate their efforts and limited remaining funds on producing the best possible prototypes to meet the objectives of the Government Competitive Test (GCT). Sikorsky decided to reduce their expenditures by eliminating LSA. Consequently, the maintenance manhours reported in the QQPRI prepared by the Materiel Developer in July 1976 were based on limited and incomplete MEA estimates.

The FQQPRI was amended (AFQQPRI) in November 1976, to reflect maintenance manhours per flight hour by MOS at AVUM level based on RAM data collected during approximately 560 GCT flight hours per contractor. Insufficient data was obtained during GCT for an MOS breakout at AVIM level. Also, the data presented was a combination of direct and indirect maintenance manhours. Table III-2 illustrates the AVUM maintenance manhour data extracted from the July 1976 FQQPRI and the November 1976 AFQQPRI.

In order to permit a reasonable comparison between the direct maintenance manhours in the FQQPRI and the combined direct and indirect maintenance manhours per flight hour reported in the AFQQPRI, the amended data has been converted to estimated direct maintenance manhours. The conversion was accomplished by dividing the combined maintenance manhours per flight hour for each AVUM MOS by 1.4, the indirect productive maintenance time factor provided as a guide in Army Regulation (AR) 570-2 (Manpower Authorization Criteria).

TABLE III-2

UH-60A QQPRI Data--AVUM Direct Productive Maintenance Manhours/Flight Hour (MMH/FLT HR)

MOS	MMH/FLT HR FQQPRI JUL 1976	MMH/FLT HR AFQQPRI NOV 1976
67( )20	.703	.571
67W40	--	.021
68B30	.002	.057
68D20	.008	.057
68E20	--	.029
68F20	.021	.000

TABLE III-2 (Continued)

MOS	MMH/FLT HR FQQPRI JUL 1976	AFQQPRI NOV 1976
68F30	.001	.079
68G20	.030	.079
68H20	.002	.043
35K20	.040	.021
35L20	--	.041
35M20	--	.029
35N20	--	.043

Following the award of the production contract in December 1976, Sikorsky resumed the LSA effort, but it took about 18 months to reestablish the LSAR data base and begin to submit reports to the materiel developer. No evidence could be found to indicate that the materiel developer ever formally submitted further QQPRI amendments to upgrade maintenance manhour data reported in the July 1976 FQQPRI and November 1976 AFQQPRI.

c. UH-60A BOIP

Documentation reviewed for this study suggested that a tentative BOIP was prepared prior to the formal beginning of the UH-60A acquisition program in 1971, but no data from such a document could be found. Although called for in the LCSMM and required as a prerequisite for the decision to type classify the helicopter standard, no UH-60A BOIP was developed during the FSED phase. The DSARC III decision to proceed into the production/ Deployment Phase and an immediate follow-on decision in December

1976 to type classify the aircraft standard, were made without the benefit of either a QQPRI or BOIP. A waiver was required and granted to permit type classification of the UH-60A as standard with an understanding that both the QQPRI and BOIP would be approved by HQDA prior to execution of the optional second year production contract.

The combat developer -- U.S. Army Infantry Center (USAIC) -- began to develop the BOIP during the opening months of the Production and Deployment phase (early CY 1977). The USAIC experienced some difficulty in preparing the BOIP because of the admittedly poor estimates of productive maintenance manhours in the FQQPRI and AFQQPRI. For some maintenance MOSs, the maintenance manhours were so low that USAIC, using traditional MACRIT formulas from AR 570-2, could not justify a single space. Consequently, the estimates were "factored" to determine quantitative BOIP maintenance manpower data. No documentation could be found as to either the specific factors used or the supporting rationale for their development.

8. Training

Initial training of Army instructors, key personnel, and individuals required to participate in Government Competitive Testing (GCT) started in mid 1974 and continued until testing began in Spring 1976. Most of the early training was conducted by the competing airframe contractors (Sikorsky and Boeing-Vertol) and the T700 engine contractor (General Electric) at

their respective factories in compliance with contractual requirements to prepare and present such training.

Army resident training requirements were estimated by Sikorsky in its November 1974 PTTDAR. It was the only such forecast made during the FSED phase that could be found during this study. Table III-3 summarizes the suggested requirements. It should be recalled (paragraph 6., supra) that the dialog between Sikorsky and the Army training community was less than optimum during this period due to the competitive nature of the FSED phase.

TABLE III-3

UH-60A Resident Training Requirements
(1974 PTTDAR-Sikorsky)

MOS	Course Length	Minimum Prerequisites
67( )	6 weeks	Possess MOS 67N,R, or X and Prior Field Experience
67W	4 weeks	1 year Experience
68B	2 weeks	1 year Experience
68D	3 weeks	1 year Experience
68E	3 days	1 year Experience
68F	6 weeks	1 year Experience
60G	3 days	1 year Experience
68H	4 weeks	1 year Experience
35K	3 weeks	2 years Experience
35N	5 weeks	2 years Experience

The competitive phase (FSED) RFP asked responding prime contractors to submit recommendations for training devices.

However, a decision was made by the BLACKHAWK Program Manager (PM), shortly after the award of the FSED contract, to have the PM for Training Devices (PM TRADE) procure all UH-60A maintenance training devices. At the time this decision was made, PM TRADE was a new organization and the Army was encouraging all major system PMs to use its services. Proposed device designs submitted during this phase were based on limited access to prototype system design specifications and maintenance manuals prepared in support of GCT.

E. PRODUCTION AND DEPLOYMENT PHASE

During this phase, system deficiencies found in previous testing are corrected, operational units are trained, equipment is procured and distributed, and logistic support is provided. The primary objective is to produce and deliver to an operating unit an effective, supportable system.[11]

Figure III-7 illustrates system and MPT related events identified in the LCSMM for the Production and Deployment Phase versus those actually accomplished according to available data for the UH-60A Program.

1. Initial Operational Capability Force Development Test and Experimentation (IOC-FDTE)

As a result of early type classification of the UH-60A in December 1976, the PM initiated action to delete the requirement

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[11] LCSMM, page 2.

PRODUCTION/DEPLOYMENT PHASE

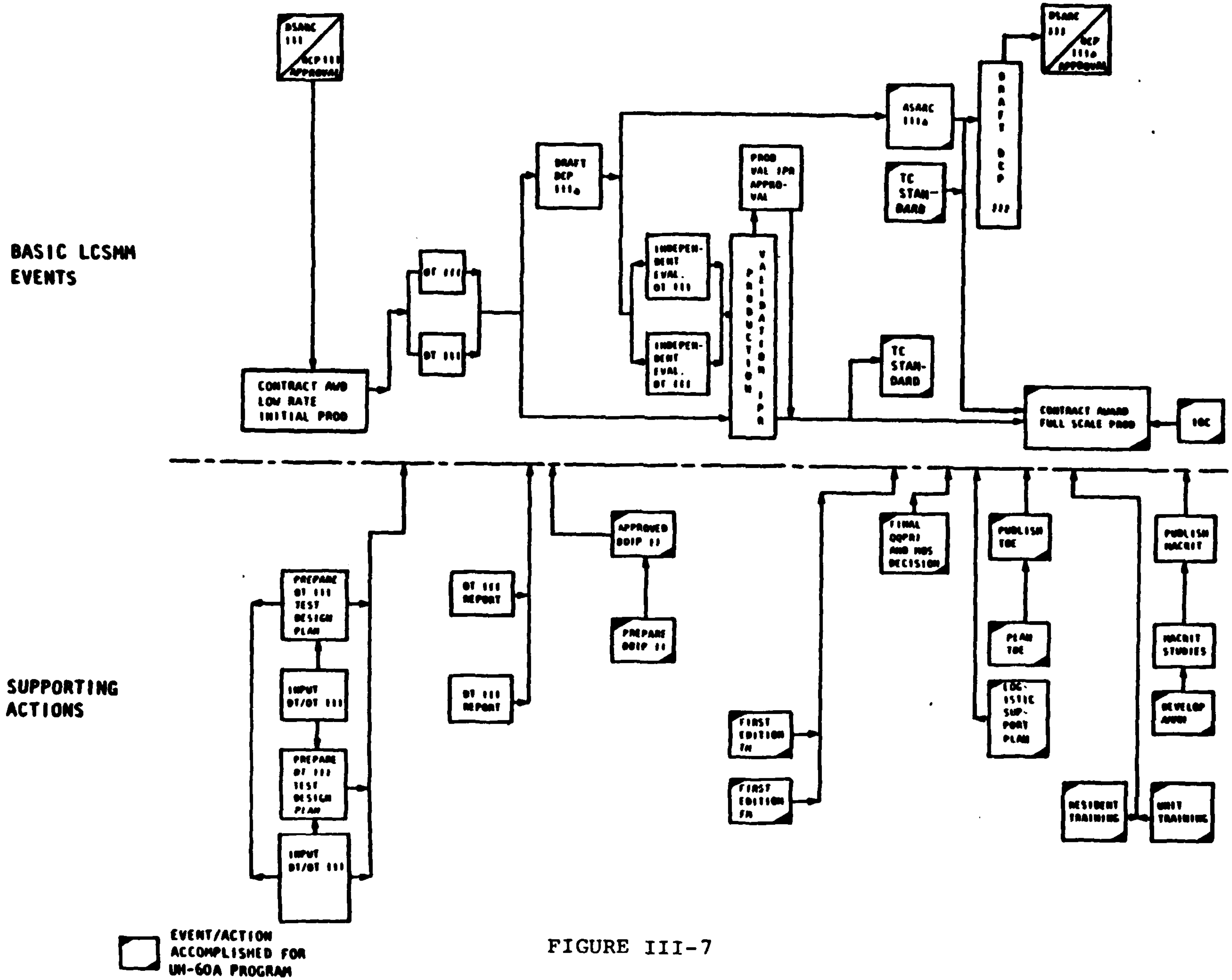


FIGURE III-7

for further operational testing. However, in order to address unresolved issues raised during the 1976 GCT and assess RAM on production aircraft, plans were made for an IOC-FDTE.

The test was conducted by the U.S. Army Aviation Board in the IOC unit at Fort Campbell, KY from 4 June to 15 October 1979. Data from the test was used by the ASARC IIIa to aid in making the decision to award a fourth year production contract to Sikorsky.

Testing found that aviator and maintenance training of test players in the IOC unit was adequate and that only minor manpower changes needed to be made in the test TOE under which the IOC unit was organized. The FDTE test report called for deletion of the one authorized MOS 55B (Ammunition Storage Specialist) due to the limited quantities of ammunition handled by the Air Assault Division CSAC. It suggested deletion of MOS 60H (Aircraft Pneudraulics Repairer) since the one task specified for that MOS at AVUM level--operational check of the hydraulic system--could be performed by an MOS 67T. The report also recommended deletion of MOS 68M (Aircraft Weapon System Repairer) because there were no helicopter mounted weapons assigned to the CSAC which required repair at AVUM level. While the MOS 68M was deleted from the test TOE in November 1980, one each MOS 55B and MOS 68H remained authorized on the basis of operational experience of the IOC unit subsequent to FDTE.

The FDTE test report recommended a net increase of four personnel in the test TOE. Specific quantitative manpower

modifications recommended are summarized in paragraph 2.e. below. Other findings which impact on MPT requirements and HFE are as follows:

- o Mission reliability criterion of .982 was not met; achieved .961 reliability at 75% confidence level.
- o Operational availability criterion of .80 was not met; achieved .755 availability.
- o Mission Flexibility Kits (MFK), Peculiar Ground Support Equipment (PGSE), and Test, Measurement and Diagnostic Equipment (TMDE), not examined during DT/OT II, received only partial evaluation during FDTE and require further testing.
- o Passengers equipped with back packs have to sit on the forward edge of the seat, causing discomfort and negating the crash attenuation properties of the seat.
- o The door gunner must leave his seat in order to fire the aircraft mounted M60 Machine gun; positioning of the weapon also makes reloading difficult and time consuming.
- o Pilot/copilot outside visibility during deceleration attitudes is difficult.
- o Verbal and visual communications are poor between the aircraft crew and gound crew during external load missions.
- o High noise levels were experienced in passenger compartment.

2. Manpower Requirements.

a. MOS Decisions.

In August 1977, the U.S. Army Military Personnel Center (MILPERCEN) announced approval of a new enlisted MOS 67T (Tactical Transport Helicopter Repairer) dedicated to supporting the UH-60A helicopter at both AVUM and AVIM maintenance levels.

Although a separate MOS had been recommended in the July 1976 FQQPRI, MILPERCEN initially considered awarding a Special Qualification Identifier (SQI) to the UH-1 repairer (MOS 67N) after appropriate transition training. Following strong objections by both the materiel and combat developers concerning the lack of commonality between UH-1 and UH-60A maintenance tasks and the difficulty of managing MOSs by SQI, the new MOS was established.

In 1977, there were two MOS decisions that affected the UH-60A qualitative requirements, although they were not directly related to the UU-60A development. First, MOS 68E (Aircraft Rotor Repairer) was eliminated and duties divided between the Powertrain Repairer (MOS 68D) and the Structural Repairer (MOS 68G). Secondly, MOS 35N (Avionic Flight Control Equipment Repairer) was eliminated and the duties assumed by the Avionic Navigation Equipment Repairer (MOS 35M).

b. Table of Organization and Equipment (TOE) Development.

The combat developer (TRADOC), faced with the requirement for developing the UH-60A TOEs, lacked confidence in the estimated quantitative maintenance manpower requirements in the BOIP; recall that they were derived from unreliable Direct Productive Annual Maintenance Manhour (DPAMMH) estimates in the FQQPRI/AFQQPRI and then adjusted by some unknown "factors". The combat developer attempted to obtain updated maintenance manhour data from the U.S. Army Materiel Readiness Support Activity (MRSA),

a subordinate element of the U.S. Army Materiel Development and Readiness Command (DARCOM).

The MRSA maintains and provides TRADOC access to a data base which reports DPAMMH on Army equipment. For those systems under development or in the early stages of fielding, LSAR information is included in the data base as the best available. In the case of the UH-60A, however, no LSAR data was found. Instead, a letter on file at MRSA indicated that LSAR information would be available for inclusion in the data base by July 1982.

Given these circumstances, the U.S. Army Infantry Center (USAIC), proponent for the Combat Support Aviation Company (CSAC) TOE, obtained an estimate of DPAMMH by MOS directly from the UH-60A Project Manager's office in January 1980, and used it to compute the quantitative maintenance manpower requirements for the CSAC TOE which was approved by HQDA. That estimate was based on the latest LSAR data, "factored" by some preliminary maintenance data collected from the Initial Operational Capability (IOC) unit and professional judgment.

At about the same time, the U.S. Army Academy of Health Sciences, proponent for the Air Ambulance Company (AAC) TOE, obtained a different estimate of DPAMMH by MOS from TRADOC Headquarters, the original source of which could not be determined. That estimate was then used to compute maintenance manpower requirements for the AAC TOE which was also approved by HQDA.

A Subject Matter Expert (SME) in the Organization Division, Deputy Chief of Staff, Combat Developments, U.S. Army Transportation School, indicated that a decision had been made sometime in 1980 to use the UH-1H helicopter MACRIT data in AR 570-2 for MOS 67N and all MOS 68 positions as the basis for computing TOE manpower requirements for the UH-60A. The approved CSAC and Air Ambulance Company TOE, reportedly reviewed by the Transportation School, did not reflect that decision. A SME in the Organization Division, Force Development and Evaluation Directorate, U.S. Army Logistics Center indicated that the TRADOC MACRIT data base maintained by that office also did not reflect that Transportation School decision.

Table III-4 compares the different estimates of DPAMMH/FLT HR used to compute TOE manpower requirements for MOS 67T and several MOS 68 skills at AVUM level.

TABLE III-4

DPAMMH/FLT HR Estimates
for Computation of UH-60A TOE Manpower Requirements
(Selected MOSs)

MOS	PM Estimate (Jan 80)	TRADOC Estimate (Jan 80)	UH-1H MACRIT (AR 570-2)
67T	1.98	.94	2.94(67N)
68B	.22	.07	.14
68D	.12	.07	.10
68F	.11	.03	.03
68G	10	.05	.14
68H	.09	.06	.03

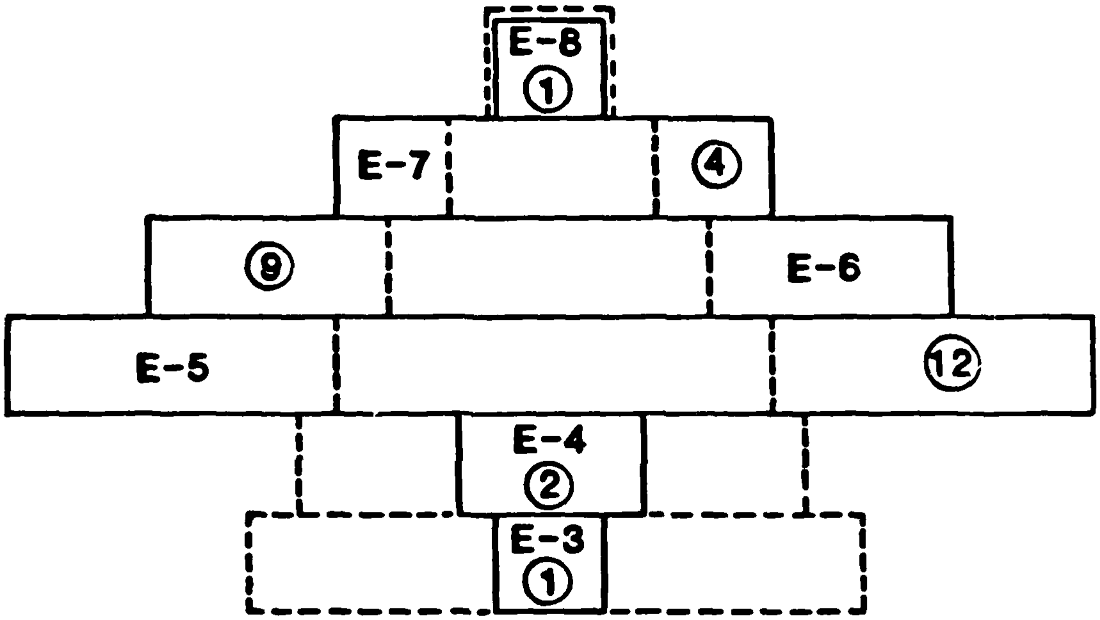
c. Grade Sustainability - MOS 67T.

A sustainable MOS is one which has sufficient lower grade positions to allow for attrition, and acquisition of proficiency and experience; to provide promotion selectivity to the next higher grade; and to produce the quality and quantity required at the next higher grade. A sustainable MOS structure is generally pyramidal in shape with a reduced number of personnel authorized at each successively higher skill level. An MOS is generally considered to be unsustainable when authorizations at a higher grade exceed authorizations at the next lower grade, thereby demanding a continuation rate in excess of 100 percent to satisfy requirements. In a 1980 study of the Army Aviation Maintenance Career Management Field (CMF) 67, HQDA concluded that there were grade sustainability problems in CMF 67 generally, and specifically cited the UH-60A CSAC Company TOE as an example. Figure III-8 graphically dipicts the MOS 67T grade structure in a CSAC.

d. Manpower Analysis Paper (MAP) III.

The combat developer (TRADOC) prepared a MAP III in October 1979 which assessed the aggregate quantitative personnel impact of fielding the UH-60A during the period FY 80-85. Using a proposed UH-60A distribution plan and net changes by Career Management Field (CMF) for each applicable TOE shown in the BOIP, the analysis predicted a net decrease of about 900 spaces over the 6-year period, attributable to UH-60A fielding. The greatest predicted reduction was in CMF 67, due primarily to replacement of 23 UH-1 aircraft in the CSAC with 15 UH-60A.

MOS 67T* GRADE DISTRIBUTION IN UH-60A CSAC



---- IDEAL GRADE DISTRIBUTION PATTERN

—— ACTUAL DISTRIBUTION PATTERN

* INCLUDES 67W/Z

FIGURE III-8

e. Manpower Comparison.

Table III-5 provides a comparison of enlisted manpower by MOS in the Air Assault Division (ASD) UH-1 Assault Helicopter Company (AAC) TOE with several iterations of the TOE for the Air Assault Division UH-60A CSAC.

TABLE III-5

UH-1/UH-60A Manpower Requirements Comparison

Air Assault Division (ASD)

		UH-60A (ASD)		
MOS	UH-1 AHC (ASD)	TOE 7-268 TEST (APR. 1979)	IOC-FDTE FINDINGS (JAN. 1980)	TOE-7-269J (NOV. 1980)
05B10	1	1	1	1
31P	0	1	1	0
31V	2	2	2	2
35K	2	2	2	2
35P	0	0	0	1
36K	2	2	2	2
54E	0	0	0	1
55B	0	1	0	1
62F	1	1	1	1
63B	7	6	6	6
64C	0	3	3	3
67N/T	44(N)	24(T)	28(T)	24(T)
67W	1	1	1	1
67Z40	4	3	3	3
67Z5M	1	1	1	1
68 Series	9	9	9	9
71 Series	5	5	5	5
76C	0	0	0	6
76D	5	4	4	0
76W	6	7	7	11
76Y	4	2	3	2
94B	5	5	5	5
TOTALS	99	80	84	89

3. <u>Training Requirements</u>

a. Resident Training Modifications.

During this phase, a number of different estimates of resident training requirements were made, beginning with the May 1977 training input to the AFQQPRI. In January 1978, an Individual and Collective Training Plan (ICTP) was prepared by TRADOC. It outlined basic UH-60A training concepts, divided operator and maintenance training responsibilities between various Army service schools, and described proposed courses to be taught at each. The U.S. Army Aviation Center was given responsibility for beginning UH-60A pilot training in 1st Quarter FY 79. The U.S. Army Infantry Center was charged with providing resident training concerning tactical employment of the UH-60A beginning in 3d Quarter FY 79, while the U.S. Army Armor Center was given the same responsibility so far as employment of the UH-60A in Air Cavalry units was concerned. The ICTP called for maintenance training to be conducted at the U.S. Army Transportation Center, except that avionic equipment maintenance would be performed at the U.S. Army Signal Center.

The October 1979 MAP III included a section concerning planned resident training by MOS as did the UH-60A Materiel Fielding Plan (MFP) published in February 1981. Table III-6 summarizes the various estimates of UH-60A training requirements for selected enlisted MOSs.

TABLE III-6

Estimates of UH-60A

Resident Training Requirements

Weeks(W)/Days(D)

MOS	1974 PTTDAR	1977 QQPRI Input	1978 ICTP	1979 MAP III	1981 MFP
67T	6W	12W-IET	12W-IET 7W-Trans	10W-IET 8W-Trans	10W-IET 8W-Trans
67W	4W	3D	1W	1W	1W
68B	2W	2W	2W	3W+	2W+
68D	3W	-	2W	3W+	3W
68F	6W	2W	3W	6W+	6W
68G	3D	2W	1W	1W+	1W
68H	4W	-	2W	3W+	2W
35K	3W	2W	2W	3W	5W
35N	5W	4W	-	-	-
*35M	-	9W	9W	-	-

IET - Initial Entry Training
Trans - Transition Training

*New MOS which absorbed 35N in Oct. 77.

b. Training Devices

Early in this phase, three small business vendors were awarded contracts to develop some 13 different devices. In an effort to have training devices available early, most of the them were built using the FSED prototype design specifications, and did not include numerous system design changes made early in the production phase on the basis of GCT results. Further, since PM TRADE procured the devices, they were not subject to type classification action; consequently, there were no formal procedures for applying system Engineering Change Proposals (ECP) to them.

In May 1981, PM TRADE agreed to fund a survey to determine the upgrade requirements for all UH-60A maintenance training devices, but the question as to who would fund the actual modifications was left unanswered. Until about 2 years ago, Other Procurement, Army (OPA) funds could be used to modify aviation system training devices, except for flight simulators. Then, HQDA made a decision that all aviation system devices would be procured, modified, and upgraded with Aviation Procurement, Army (APA) funds. PM TRADE had no APA budget line for devices other than flight simulators. HQDA, in November 1981, provided PM TRADE an appropriate APA line number, and funds became available in the 1st quarter, FY 83 to beqin upgrading of the UN-60A maintenance training devices.

IV. DETERMINATION OF MPT REQUIREMENTS - ANALYSIS

A. INTRODUCTION

As discussed in Sections II and III, the UH-60A Program has not followed the acquisition pattern outlined in the Army's LCSMM. The skipped Conceptual and Demonstration/Validation Phases are examples of how the program departed from the suggested LCSMM process. Such deviations from "standard" are neither unusual nor necessarily damaging to a system development program, as long as the acquisition community takes steps to ensure that critical events are not overlooked and to compensate for those steps that are bypassed.

The key to making the process work, particularly when the LCSMM is significantly modified, is communication. Clear, continuous, and multiple lines of formal and informal communication should be established early in the acquisition process between counterparts representing the materiel developer, combat developer, tester, and contractor(s). While simple enough in theory, this seems to rarely happen in actual practice. Often, equivalent counterparts either do not exist or, at best, are hard to find in all segments of the heterogeneous acquistion community for a given system. Organizational and geographical separation combined with inequalities among counterparts in such areas as experience, training, grade level, organizational depth, program priority, and assignment stability also weaken communication effectiveness and consistency.

The UH-60A Program has not been immune to this problem. Underlying most of the issues addressed in this analysis is evidence of either good or poor communication, depending on how the issue was handled.

B. HUMAN FACTORS ENGINEERING

How well soldier and machine interface in any new system is largely a function of how well and how early human factors engineering is integrated into the total system design. This is not to imply that full or even prime responsibility for effective Soldier-Machine Interface (SMI) falls on the shoulders of the Human Factors Engineer working for the system contractor. On the contrary, the ultimate responsibility for ensuring good system SMI rests with the Army itself. The Army acquisition community generally and the combat developer or other appropriate user representative specifically should become aggressively involved in the initial process of defining a new system. Hardware description ought to include HFE/MPT requirements and constraints to be considered in the basic design.

The second and more difficult step is articulation of constraints and/or requirements to contractors in precise language that can be both understood and applied during the design process; simple reference to military standards and specifications is not enough. It can be argued that detailed specifications dampen design initiative and imagination and lead to development of systems which are inferior to those designed with

relatively few constraints. The counter argument is that life cycle cost considerations, in terms of both dollars and people, require that contractors be given some specific criteria concerning operation and maintenance of proposed systems. Otherwise, a contractor might design a highly capable and even cheap to produce system, but one which can be neither operated nor maintained by projected available manpower (quantitative or qualitative).

Language in RFPs and contracts related to MPT/HFE requirements/constraints, in addition to being definitive and precise, should be adamant and enforceable. In RFPs, for example, HFE/MPT issues ought to be specifically and significantly weighted in the source selection criteria.

As pointed out in Section III. D.2., supra, HFE for the UH-60A was emphasized in the RFP and contractual documents by requiring contractors to perform specific HFE tasks, and submit HFE reports. The PM Office indicated that, in addition to the contractual HFE requirements, design reviews of prototype mockups in the FSED phase were done at the airframe and engine factories using soldiers from units in the field. Although no documentation of this effort could be found, Subject Matter Experts (SMEs) interviewed for this study agreed that it was an effective technique for integrating HFE into system design. These efforts did not produce perfect compatibility between man and machine in the functioning of all the complex components of the system (see Section III.E.1., supra). However, they did

reduce the number and magnitude of HFE problems experienced in the overall development of the UH-60A when compared to such problems experienced during the development of like and similar aviation systems as well as other systems examined during this study, e.g., AN/TTC-39 and FIREFINDER programs.

The Army developed well defined Reliability, Availability, and Maintainability (RAM) criteria for the tactical transport helicopter, and placed high priority on achievement of those RAM goals by competing contractors in the FSED phase. As a result, RAM considerations contributed as much or more than did the HFE program itself to an aircraft design characterized by effective soldier-machine interface.

There was no evidence that the US Army Human Engineering Laboratory (HEL) provided any HFE assistance or advice to either the PM or contractors during the FSED phase. Further, no Human Factors Engineering Analysis (HFEA) was ever performed concerning the UH-60A. Had HEL supported tbe UH-60A program, it is reasonable to assume that the HFE effort might have been even more successful than it apparently was. For example, it is possible that some of the HFE shortcomings discovered on production aircraft during FDTE might have been highlighted earlier and corrected before delivery to the IOC unit.

C. QUALITATIVE MANPOWER REQUIREMENTS

There is no reliable standard set of tools/techniques for determining qualitative manpower requirements for new Army

systems; however, a number of research initiatives are underway to develop such a methodology. Currently, Subject Matter Experts (SME) in the Army's materiel (DARCOM) and combat (TRADOC) development communities independently estimate qualitative requirements using a variety of criteria such as professional judgement; operational and maintenance experience with like or similar systems; the existing MOS structure; and when available, task and skill analyses generated either by LSA or other similar processes. The qualitative estimation process is initiated by the materiel developer and documented in a QQPRI.

In the case of the UH-60A program, qualitative manpower requirements have remained relatively unchanged since the first documented estimate was made in the July 1976 FQQPRI. That circumstance can be partially attributed to the factors cited below.

- The FQQPRI was developed late in the FSED phase where a great deal more was known about the aircraft design. Had a QQPRI been prepared early in the FSED phase, its qualitative estimate of manpower may not have been as accurate.

- Although significant technological advances are reflected in the UH-60A design, the UH-60A helicopter is replacing a like and similar system (UH-1).

- The UH-60A specifications provided to contractors at the beginning of the FSED phase were more detailed and specific than those normally given to new system contractors.

- Most UH-60A Subject Matter Experts (SME) in both the materiel (DARCOM) and Combat (TRADOC) development communities had significant prior aviation experience and familiarity with the aviation community.

- A task and skill analysis was performed by the contractor and documented in the 1974 PTTDAR; it provided a

reasonable basis for government estimates of qualitative requirements in the July 1976 FQQPRI.

D. QUANTITATIVE MANPOWER REQUIREMENTS

1. General

The tools and techniques for determining quantitative manpower requirements are no more standard or analytically sound than those in use for estimating qualitative needs. Quantitative estimation techniques currently in use include professional judgment, particularly for operator positions; operational and maintenance experience with like or similar systems; O&O concepts, including usage and displacement rates; and for maintenance requirements, DPAMMH, either estimated or generated by the LSA process, in combination with factors provided in AR 570-2, Manpower Authorization Criteria (MACRIT).

The quantitative process, like the qualitative, is initiated by the materiel developer (usually a subordinate Materiel Development and/or Readines Command (MDC/MRC) within DARCOM, e.g., Army Aviation Research and Development Command in the case of the UH-60A) through preparation of a QQPRI. Quantitative inputs to the QQPRI include an estimate of direct operators needed to make up a single shift crew, and DPAMMH by MOS and level of maintenance for each system component. Except for the direct crew size, the materiel developer makes no independent estimate of quantitative manpower requirements. The combat developer (usually a proponent school within TRADOC, e.g., the U.S. Army

Infantry School in the case of the UH-60A) makes the quantitative estimate using data from the QQPRI, and employing some combination of the nonstandard tools listed above. The quantitative estimate is then documented in a BOIP which lists changes in manpower by MOS and grade required in each Army organization slated to receive the system.

2. Manipulation of UH-60A DPAMMH.

As discussed in paragraph III.E.2.b., and illustrated in Table III-4, supra, there are a number of widely divergent estimates of Direct Productive Annual Maintenance Manhour (DPAMMH) data which could be used to calculate UH-60A maintenance manpower requirements. The effect of using these inconsistent DPAMMH in the manpower formula is significant. The impact can be best demonstrated in the computation of MOS 67T (Tactical Transport Helicopter Repairer) requirements for a notional UH-60A CSAC using various DPAMMH per Flight Hour (FLT HR) and the MACRIT formula provided in AR 570-2. Table IV-1 summarizes the results from such computations.

The computations in Table IV-1 were based on the following assumptions and formula:

- Aircraft Density (AD) = 15
- Annual Flying Hours (AFH) = 828
- Indirect Productive Time Factor (IPTF) = 1.4
- Available Annual Productive Manhours (AAPMH) = 2700

- DPAMMH/FLT HR = Variable
- No adjustment made for flying crewchief
- Number of Positions (Nr Psns) =

$$\frac{\text{DPAMMH/FLT HR} \times \text{IPTF} \times \text{AFH} \times \text{AD}}{\text{AAPMH}}$$

TABLE IV-1

MOS 67T Positions For Notional UH-60A CSAC Using Various DPAMMH/FLT HR

DPAMMH/FLT HR	Source	Nr Psns
0.57	QQPRI (Nov. 76)	4
1.98	PM Estimate (Jan. 80)	13
0.94	TRADOC HQ Est (Jan. 80)	6
1.61	LSAR (Jan. 82)	10
2.94	UH-1H (AR 570-2)	19

A fundamental problem in determining specific TOE maintenance manpower requirements for any materiel system is that the DPAMMH, a key element in the equation, must be based on either Logistic Support Analysis Record (LSAR) estimates or existing Manpower Authorization Criteria (MACRIT) for a similar system provided in Army Regulation (AR) 570-2 (MACRIT). Development of

TOE cannot be delayed until sufficient field maintenance data is collected and validated by a MACRIT study for the new system.

The decision to use either LSAR estimates or similar system MACRIT data, if available, is a difficult one. The acquisition community generally regards LSAR estimates of DPAMMH as low, and manpower planners are often reluctant to use the data for fear of underestimating the true maintenance manpower requirements for the system. On the other hand, the use of MACRIT data for an existing similar system, which may be more manpower intensive, will tend to nullify any projected manpower savings for the new system.

The TOE development problem is further complicated by the fact that the low manpower estimates, based on LSAR data, are traditionally used in documents such as the Basis of Issue Plan (BOIP) and Manpower Analysis Paper (MAP). Data from these documents are used during ASARC/DSARC reviews and the Program Objective Memorandum (POM) process, and can lead to overly optimistic estimates of quantitative maintenance manpower requirements.

In the case of the UH-60A, early LSAR data was obviously incomplete and admittedly poor. This is largely attributable to the fact that LSA, as currently practiced under MIL STD 1388A, was in its infancy and undergoing significant changes during the early development of the UH-60A. This circumstance was compounded by complete stoppage of LSA by Sikorsky in 1974 because

of funding difficulties. Although LSA was restarted in 1977, the reliability of the data remained low for some 18 to 24 months thereafter.

In addition to the fundamental difficulty of determining accurate DPAMMH on the basis of LSAR, there appears to have been a lack of effective formal communication between the DARCOM and TRADOC communities concerning the need to develop a realistic and consistent set of DPAMMH figures to facilitate UH-60A manpower planning. Such an effort would have been and may still be of value in the case of the UH-60A Program since several different TRADOC schools have proponency for UH-60A TOEs.

3. Maintenance Requirement.

The UH-60A MN predicted that quantitative maintenance manpower requirements should decrease due to lower aircraft density and design requirements for simplified maintenance. Analysis of data in Table III-5, supra, indicates that there has been a decrease in helicopter repairers (MOS 67T vs MOS 67N) which is generally proportionate to the decrease in aircraft density. However, there has been no apparent decrease in manpower requirements attributable to simplified maintenance. In fact, the same net number of component repairers (MOS 68 series) called for in the UH-1 CSAC are required in the UH-60A CSAC, despite a reduction in aircraft. This may be due in part to the twin engine configuration of the UH-60A vs the UH-1's single engine. Nevertheless, there are no quantitative reductions in maintenance

manpower due to simpler design as predicted. Further, there is an appreciable increase in the UH-60A vs the UH-1 requirements for MOS 76W (Aircraft Fuels Handler) which was not foreseen in any early manpower document reviewed for this study. The predictable increase is also attributable in part to the twin engine design of the UH-60A.

4. Door Gunner Augmentation.

Door gunner augmentation positions are classified as MOS 67T, and are based on one per authorized UH-60A aircraft, excluding those assigned to air ambulance units. The 1980 study of CMF 67 correctly observed that this results in an inherent mobilization problem in terms of the total number of personnel required to fill these positions and the training associated with qualifying them as skill level 1 helicopter repairers/door gunners. This problem still exists and was not addressed in any documentation found during this study.

E. TRAINING REQUIREMENTS

1. General.

A credible estimate of training requirements (course length & content) for a new system is possible only if the prediction of qualitative operator and maintenance manpower is accurate. The two are inexorably linked, thereby suggesting that the combat developer (TRADOC proponent school) should be the key participant in the process of performing both appraisals.

Within the acquisition community, a proponent school for any given CMF is theoretically in the best position to know all the dynamics affecting MOSs in that CMF, e.g., other new systems planning to use the same MOS, training shortfalls reported by field units, CMF restructing studies, and difficulties in meeting training projections (input or output).

2. Combat Development Proponency - Aviation Systems.

As a rule, the proponent school for the CMF(s) most directly involved in operation and/or maintenance of a given Army system is assigned primary MPT requirements determination proponency for the system as well. Aviation systems, however, are often exceptions to that rule.

In the case of the UH-60A, the proponent school is the U.S. Army Infantry Center (USAIC), Ft. Benning, GA, which has no responsibility for training any CMFs involved in either operation or maintenance of the system. Since the UH-60A is primarily an infantry squad carrier, USAIC does conduct training concerning loading, unloading and tactical employment of the UH-60A. System operators (aviators) are trained at the U.S. Army Aviation Center, Ft. Rucker, AL. Primary maintainers (CMF 67) are trained at the U.S. Army Transportation Center, Ft. Eustis, VA, and avionics repairers (CMF 29) are trained at the U.S. Army Signal Center, Ft. Gordon, GA.

Assignment of combat development proponency to a school having no operator/maintainer training responsibilities, and thus no

first hand working knowledge of aviation training requirements, does not appear to have had an adverse effect on the process of determining UH-60A training requirements. Nevertheless, centralization of aviation system proponency within TRADOC cannot help but improve the efficiency of overall MPT planning for new aviation systems, particularly in the area of calculating quantitative maintenance manpower requirements.

3. Training Estimate Accuracy.

Analysis of various maintainer MOS training estimates illustrated in Table III-6, supra, indicates fairly consistent predictions, over time, concerning the lengths of UH-60A training courses. In building a case for a separate UH-60A repairer MOS (67T), the acquisition community emphasized the dissimilarity between maintenance of the UH-1 and UH-60A. Latest training estimates, which indicate only two weeks difference in Initial Entry Training (10 weeks) and transition training (8 weeks) for MOS 67T, seem to substantiate that premise.

4. Training Devices.

The Army owns a UH-60A composite maintenance trainer and a number of other part task maintenance training devices, all built to pre-production phase design specifications. As pointed out in paragraph III.E.3.1., supra, not one of the many design changes, which have been made to the aircraft since early in the production phase, had been applied to these devices as of the end of FY 82.

Since no UH-60A maintenance training device the Army owns resembles the aircraft component(s) it presumes to replicate for training purposes, training quality has been adversely affected. A Subject Matter Expert (SME) at the U.S. Army Training Support Center (ATSC) estimated that, overall, the devices were about 30-40 percent effective. A combination of the following factors contributed to this problem:

- o Transferring responsibility for procurement of UH-60A training devices to PM TRADE without either assigning responsibility or earmarking funds for upgrading the devices as engineering changes were made to aircraft during the production phase.

- o Restricting bids on the development and manufacture of devices to small businesses only.

- o Failing to provide winning bidders sufficient up-to-date aircraft design data at the outset of device fabrication, thereby making the original devices obsolete the moment they were issued.

V. CONCLUSIONS

A. Precise specification of Reliability, Availability, and Maintainability (RAM) criteria and emphasis on achievement of RAM goals by competing contractors led to early consideration of MPT issues and specific HFE input to the UH-60A design process. As a result, few HFE deficiencies were identified during the 1976 GCT, and early qualitative manpower estimates proved to be very accurate.

B. Suspension of formal Logistic Support Analysis (LSA) by Sikorsky from the middle of the FSED phase (1974) until the beginning of the Production phase (1977) hindered the Army's ability to predict quantitative maintenance manpower and training requirements. Specifically, predictions of DPAMMH for MOSs at both AVUM and AVIM levels were based on weak and incomplete LSA, thereby reducing the reliability of early quantitative estimates. This situation was compounded by the fact that initial DPAMMH reported in the July and November 1976 QQPRIs were never formally modified by improved LSA and published in amended QQPRIs.

C. Low confidence of manpower planners in the DPAMMH data produced by early LSA, the lack of a central Army authority for new system manpower planning, and failure of combat developers to clearly communicate and coordinate with counterparts in the materiel development community and among themselves, led to the uncoordinated use of at least three different estimates of "factored" DPAMMH in the computation of UH-60A quantitative maintenance manpower requirements.

D. Early predictions in the MN concerning quantitative maintenance manpower requirements for the UH-60A were inaccurate. The predicted decrease attributable to design requirements for simplified maintenance and longer component life was not balanced against the twin engine configuration of the aircraft. In a CSAC where 15 UH-60A aircraft replace 23 UH-1H helicopters, the total number of aircraft component repairers (MOS 68 series) remains the same.

E. Procurement and upgrading of UH-60A maintenance training devices was poorly managed, and has resulted in degradation of maintenance training quality (CMFs 67 and 29).

F. Manpower, Personnel, and Training requirements attributable to operation and maintenance of Mission Flexibility kits (MFK), Peculiar Ground Support Equipment (PGSE), and Test, Measurement and Diagnostic Equipment (TMDE) were still not fully known at the time the helicopter was fielded. Due in part to acceleration of the UH-60A acquisition program (first two phases bypassed), operational testing of the MFK, PGSE, and TMDE was not possible prior to system fielding, and the Force Development Test and Experimentation done at IOC only partially evaluated these items.

APPENDIX A

MAJOR MPT RELATED REFERENCES

POLICIES & PROCEDURES

Department of Defense

DoD Directive 5000.1, Major System Acquisition

DoD Directive 5000.39, Acquisition and Management Support for Systems and Equipment

DoD Instruction 5000.2, Major Systems Acquisition Process

ASD(MRA&L) Memorandum, "Manpower Analysis Requirements for System Acquisition", August 1978.

MIL-STD-1388 Logistic Support Analysis, October 1973

Proposed MIL-STD-1388A, Weapon System and Equipment Support Analysis, November 1981 (Draft)

MIL-STD-1472B, Human Engineering Design Criteria for Military Systems, Equipment, and Facilities, December 1974

MIL-H-46855B, Human Engineering Requirements for Military Systems, Equipment, and Facilities

Department of the Army

AR 1-1	Planning Programming and Budgeting Within the Department of the Army
AR 10-4	US Army Operational Test and Evaluation Agency
AR 10-5	Department of the Army
AR 10-11	US Army Materiel Command
AR 10-25	US Army Logistics Evaluation Agency
AR 10-41	US Army Training and Doctrine Command
AR 11-4	System Program Reviews
AR 11-8	Principles and Policies of the Army Logistic System
AR 15-14	Systems Acquisition Review Council Procedures
AR 70-1	Army Research, Development and Acquisition
AR 70-2	Materiel Status Recording

AR 70-10	Test and Evaluation During Development and Acquisition of Materiel
AR 70-16	Department of the Army System Coordinator (DASC) System
AR 70-27	Outline Development Plan/Development Plan, Army Program Memorandum/Defense Program Memorandum/ Decision Coordinating Paper
AR 70-61	Type Classification of Army Materiel
AR 71-1	Army Combat Developments
AR 71-2	Basis of Issue Plans
AR 71-3	User Testing
AR 71-9	Materiel Objectives and Requirements
AR 71-10	Department of the Army Force Integration Staff Officer (FISO) System
AR 310-31	Management System for Tables of Organization and Equipment (The TOE System)
AR 310-34	Equipment Authorization Policies and Criteria, and Common Tables of Allowances
AR 310-49	The Army Authorization Documents System (TAADS)
AR 350-1	Army Training
AR 350-10	Management of Army Individual Training Requirement and Resources
AR 350-35	New Equipment Training and Introduction
AR 570-2	Organization and Equipment Authorization Tables - Personnel
AR 602-1	Human Factors Engineering Program
AR 611-1	Military Occupational Classification Structure Development and Implementation
AR 611-201	Enlisted Career management Field and MOSs
AR 70-18	Provisioning of U.S. Army Equipment
AR 700-127	Integrated Logistic Support
AR 702-3	Army Materiel Reliability, Availability and Maintainability (RAM)

AR 750-1	Army Materiel Maintenance Concepts and Policies
AR 750-43	Test, Measurement, and Diagnostic Equipment
AR 1000-1	Basic Policies for Systems Acquisition
DA PAM 11-2	Research and Development Cost Guide for Army Materiel Systems
DA PAM 11-3	Investment Cost Guide for Army Materiel Systems
DA PAM 11-4	Operating and Support Cost Guide for Army Materiel Systems
DA PAM 11-5	Standards for Presentation and Documentation of Life Cycle Cost Estimates for Materiel Systems
DA PAM 11-25	Life Cycle System Management Model for Army Systems
DA PAM 700-125	Integrated Logistics Support (ILS) Management Model and Glossary

Army Modernization Information (AMIN), 1979, 1980, 1981.

<u>U.S. Army Training and Doctrine Command (TRADOC)</u>

TRADOC Reg 11-1	Manpower Analysis and Force Structuring in the Combat Development Process
TRADOC Reg 11-8	Combat Development Studies
TRADOC Reg 71-9	User Test and Evaluation
TRADOC Reg 71-12	Total System Management - TRADOC System Manager (TSM)
TRADOC Reg 71-77	Unit Reference Sheets
TRADOC Reg 350-4	The TRADOC Training Effectiveness Analysis (TEA) System
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TRADOC PAM 70-2	DARCOM/TRADOC Materiel Acquisition HDBK, January 1980
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<u>U.S. Army Materiel Development and Readiness Command (DARCOM)</u>

DARCOM HDBK 700-1.1-81	ILS primer (1st and 2nd Editions)
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O'Connor, Francis E., et al, AN/TTC-39 Program -- A Case Study of MPT Requirements Determination, 31 March 1983.

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Rhode, Alfred S., et al, Manpower, Personnel and Training Requirements for Materiel System Acquisition, ARI, February 1980.

APPENDIX B

BLACKHAWK (UH-60A) Program Data Collection Sources

(Agencies/Offices)

Headquarters, Department of the Army (HQDA), Washington, D.C.

- o DA System Coordinator (DASC), Office of the Deputy Chief of Staff, Research, Development, and Acquisition (OSCSRDA).
- o Force Integration System Officer (FISO), Office of the Deputy Chief of Staff, Operations (ODCSOPS).
- o Requirements Directorate, ODCSOPS
- o Training Directorate, ODCSOPS
- o Army Force Modernization Coordination Office (AFMCO), ODCSOPS
- o Manpower Programs and Budget Directorate, Office of the Deputy Chief of Staff, Personnel (ODCSPER)

US Army Materiel Development and Readiness Command (DARCOM)

- o Headquarters, DARCOM, Alexandria, VA
  - Directorate for Development, Engineering & Acquisition
  - Directorate for Management
  - Directorate for Supply, Maintenance & Transportation
- o Troop Support and Aviation Materiel Readiness Command (TSARCOM), St. Louis, MO
  - BLACKHAWK Program Management Office
  - Maintenance Engineering Directorate
  - Personnel, Training, and Force Development Directorate
- o Materiel Readiness Support Activity (MRSA), Lexington Blue Grass Army Depot, KY
  - Maintenance Division
  - Readiness Division
- o Human Engineering Laboratory (HEL), Aberdeen, MD

- o Materiel Systems Analysis Activity (AMSAA), Aberdeen, MD
    - Combat Support Division
    - Reliability, Availability, and Maintainability Division

US Army Training and Doctrine Command (TRADOC)

- o Headquarters, TRADOC, Ft. Monroe, VA
    - Deputy Chief of Staff, Combat Developments
    - Deputy Chief of Staff, Training
- o US Army Aviation School, Ft. Rucker, AL
    - TRADOC System Manager (TSM), BLACKHAWK (UH-60A) Program
- o US Army Infantry School, Ft. Benning, GA
    - Combat Developments Directorate
- o US Army Transportation School, Ft. Eustis, VA
    - Combat Developments Directorate
    - Training and Doctrine Directorate
- o Soldier Support Center - National Capital Region (SSC-NCR), Alexandria, VA
    - Military Occupational Development Directorate
    - Personnel Resources Analysis Directorate
- o Logistics Center, Ft. Lee, VA
- o Training Support Center, Ft. Eustis, VA

US Army Operational Test and Evaluation Agency (OTEA), Falls Church, VA

Sikorsky Aircraft Division, United Technologies Corporation, Stratford, CT

- o BLACKHAWK Program Division

APPENDIX C

UH-60A (BLACKHAWK) PROGRAM

DOCUMENTATION REVIEWED

System Requirements/Decisions

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DSARC I/II Minutes, May 1971, OSD

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DCP #13, November 1977, HQDA

ASARC IIIA minutes, October 1979, HQDA

Contractual

Request for Proposals (Extracts), December 1971, Army Material Command

Attachment 2:	Systems Specification with revisions ('75 and '76)
Attachment 3:	Reliability Program Requirement
Attachment 4:	Maintainability Program Requirement
Attachment 5:	Logistic Management Requirement
Attachment 10:	Human Factors Engineering (HFE)

Statements of Work for Basic Engineering Development Phase (Extracts), Sikorsky, July 1972

Attachment 4:	Contractor Recommended Support Plan.
Attachment 11:	HFE Program

Statements of Work for Low Rate Initial Production Phase (Extracts), Sikorsky, November 1976

- Maintainability Program
- Reliability Program
- Personnel and Training

Manpower/Personnel

Personnel, Training, and Training Device Analysis Report (PTTDAR), Sikorsky,

Initial Submittal: November 1974
First Update: September 1976
Final Submittal: April 1977

Final Qualitative and Quantitative Personnel Requirements Information (FQQPRI), U.S. Army Aviation Systems Command, July 1976.

Ammended FQQPRI, Aviation Systems Command, November 1976, with Input and Comments from U.S. Army Infantry, Aviation, Transportation, and Signal Centers.

Basis of Issue Plan Feeder Data 69-0381-I, Aviation Systems Command, October 1976

Basis of Issue Plan 69-0381-F, December 1980

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MOS Decision, MILPERCEN, November 1979.

Manpower Analysis Paper III, U.S. Army training Doctrine Command (TRADOC), October 1979.

Logistics Support Analysis Record (LSAR) Summary Report #01, "Direct Annual Maintenance Manhours by Skill Specialty Code and Level of Maintenance," Sikorsky, January 1982.

Training

Training Support Work Group Minutes, March 1977 and July 1977

Individual and Collective Training Plan (ICTP), TRADOC, January 1978.

New Equipment Training Plan (NETP), DARCOM, 31 May 1981.

Test and Evaluation

Independent Evaluation Report (IER) of Development Test II, U.S. Army Materiel Systems Analysis Activity (AMSAA), Interim Note C-94, December 1976.

IER-OT-043, Operational Test and Evaluation Agency (OTEA), November 1976

Evaluation of RAM and Durability, AMSAA Technical Report 290, January 1980

Initial Operational Capability Force Development Test and Experimentation (IOC-FDTE) Final Report, U.S. Army Aviation Board, January 1980.

<u>Miscellaneous</u>

New Materiel Introduction - Personnel of Training Support Plan, Army Aviation Systems Command, February 1976

Cost and Operational Effectiveness Analysis (COEA), Special Study Group, Army Infantry Center, December 1976

Selected Briefing Slides, Source Selection Evaluation Board, November 1976

Correspondence (DARCOM, TRADOC, HQDA) concerning request for, approval of and extension of waiver of BOIP; QQPRI; Training Devices; Peculiar Ground Support Equipment; Test, Measurement and Diagnostic Equipment; and Mission Flexibility kits required for Type Classification Standard Decision, Oct - Nov 1976 and November 1979.

Development Plan, Volume III (Extracts), UH-60A Program Manager, February 1978

Section V: Plan for Personnel Training
Section VI: Plan for Logistic Support

Army Aviation Maintenance Career Management Field 67 Study, HQDA (ODCSLOG), October 1980

Army Modernization Information Memorandum (AMIN), HQDA (AFMCO), 1980 and 1981

CONUS Material Fielding Plan, DARCOM, February 1981.

TOE (TEST) 07-268TFC01, Combat Support Aviation Company (CSAC), 1979

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TOE 07-257J100 (CSAC-Division 86), 1982.

APPENDIX D

GLOSSARY OF ACRONYMS

AAO--Authorized Acquisition Objective
AAPMH--Available Annual Productive Man-Hours
AD--Advanced Development
ADP--Automatic Data Processing
ADTA--Aircraft Development Test Activity
AEFA--Aviation Engineering Flight Activity
AFH--Annual Flight Hours
AFMCO--Army Force Modernization Coordination Office
ALMC--Army Logistics Management Center
AMIM--Army Modernization Information Memorandum
AMMH--Annual Maintenance Manhours
AMSAA--Army Material Systems Analysis Activity
AP--Acquisition Plan
APA--Aviation Procurement-Army
APM--Army Program Memorandum
AR--Army Regulation
ARI--Army Research Institute for the Behavioral and Social Sciences
ARTEP--Army Training Evaluation Program
ASARC--Army System Acquisition Review Council
ASD,C^3I--Assistant Secretary of Defense, Command, Contro, Communications, and Intelligence
ASD, MRAL--Assistant Secretary of Defense, Manpower, Reserve Affairs, and Logistics
ASI--Additional Skill Identifier
ASIOE--Associated Support Items of Equipment
ASP--Ammunition Supply Plant
ASVAB--Armed Services Vocational Appitude Battery
ATE--Automatic Test Equipment
ATSC--Army Training Support Center
AURS--Automated Unit Reference Sheet
AUTODIN--Automatic Digital Network
AVIM--Aviation Intermediate Maintenance
AVUM--Aviation Unit Maintenance

BCE--Baseline Cost Estimate
BCS--Battery Computer System
BITE--Built-In Test Equipment
BLACKHAWK--UH-60 Utility Helicopter
BN--Battalion
BOI--Basis of Issue
BOIP--Basis of Issue Plan
BTA--Best Technical Approach
BTRY--Battery
C^3--Command, Control & Communications
C^3I--Command, Control, & Communications, and Intelligence
CAC--US Army Combined Arms Center
CAIG--Cost Analysis Improvement Group
CARDS--Catalog of Approved Requirements Documents
CD-Combat Developer
C-E--Communications-Electronics
CECOM--US Army Communications and Electronics Command
CEFR--Communications-Electronics Functional Review
CFE--Contractor Furnished Equipment
CFP--Concept Formulation Package
CFV--Cavalry Vehicle System
CM--Configuration Management
CMF--Career Management Fueld
CMMH--Corrective Maintenance Manhours
COA--Comptroller of the Army
COEA--Cost and Operational Effectiveness Analysis
COMSEC--Communications Security
CONUS--Continental United States
CPFF--Cost Plus Fixed Fee
CPIF--Cost Plus Incentive Fee
CPG--Central Processor Group
CPX--Command Post Exercise
CSA--Chief of Staff, US Army

CTA--Common Table of Allowances
CTEA--Cost and Training Effectiveness Analysis
CTP--Coordinated Test Program
DA--Department of the Army
CSAC--Combat Support Aviation Company
DAPAM--US Army Materiel Development and Readiness Command
DASC--Department of the Army System Coordinator
DCA--Defense Communication Agency
DCP--Decision Coordinating Paper
DCSLOG--Deputy Chief of Staff for Logistics
DCSOPS--Deputy Chief of Staff for Operations and Plans
DCSPER--Deputy Chief of Staff for Personnel
DCSRDA--Deputy Chief of Staff for Research, Development, and Acquisition
DDRE--Director of Defense Research and Engineering
DEPSECDEF--Deputy Secretary of Defense
DIO--Director of Industrial Operations
DOD--Department of Defense
DODD--Department of Defense Directive
DODI--Department of Defense Instruction
DP--Development Plan
DPAMMH--Direct Productive Annual Maintenance Manhours
DPM--Defense Program Memorandum
DS--Direct Support
DSARC--Defense System Acquisition Review Council
DSMC--Defense Systems Management College
DT--Developmental Testing
DT (I, II, III)--Development Test (I, II, III)
DTC--Design to Cost
DTUPC--Design to Unit Production Cost
EARA--Equipment Authorization Review Activity
ECP--Engineering Change Proposal
EQUATE--Electronic Quality Assurance Test Equipment
FACS--Field Artillery Center & School
FAMAS--Field Arfillery
Meteorological Acquisition System
FDTE--Force Development Testing and Experimentation
FIREFINDER--AN/TPQ-36 Mortar Locating Radar & AN/TPQ-37 Artillery Locating Radar
FISO--Force Integration System Officer
FM--Field Manual
FMMRS--Force Modernization Milestone Reporting System
FOE--Follow-On Evaluation
FORSCOM--US Army Forces Command
FQQPRI--Final QQPRI
FSED--Full Scale Engineering Development
FVS--Fighting Vehicle System
FY--Fiscal Year
FYTP--Five Year Test Program
GCT--Government Competitive Test
GEMM--Generalized Electronics Maintenance Model
GFE--Government Furnished Equipment
GS--General Support
GSRS--General Support Rocket System
HEL--US Army Human Engineering Laboratory
HEMAT--Heavy Expanded Mobility Ammunition Trailer
HEMTT--Heavy Expanded Mobility Tactical Truck
HET--Heavy Expanded Truck
HF--Human Factors
HFE--Human Factors Engineering
HHS--Headquarters and Headquarters & Service Battery
HQDA--Headquarters, Department of the Army
ICTP--Individual and Collective Training Plan
IEP--Independent Evaluation Plan

IER--Independent Evaluation Report
IFV--Infantry Fighting Vehicle
ILS--Integrated Logistic Support
ILSM--Integrated Logistic Support Manager
ILSMM--Integrated Logistic Support Management Model
ILSMT--Integrated Logistic Support Management Team
IOC--Initial Operational Capability
IPR--In Process Review
IPS--Integrated Program Summary
IPTF--Indirect Productive Time Factor
ISI--Information Spectrum, Inc.
ISMMH--Inspection & Servicing Maintenance Manhours
ITV--Improved TOW Vehicle
JCS--Joint Chiefs of Staff
JTA--Joint Table of Allowances
JWG--Joint Working Group
LCSMM--Life Cucle System Management Model
LEA--US Army Logistics Evaluation Agency
LIN--Line Item Number
LLM--Launcher Loader Module
LOA--Letter of Agreement
LOGCEN--US Army Logistics Center
LOGSACS--Logistic Structure & Composition Sys.
LON--Letter of Notification
LP/C--Launch Pod/Container
LR--Letter Requirement
LRIP--Low Rate Initial Production
LSA--Logistic Support Analysis
LSAR--Logistic Support Analysis Record
LSP--Logistic Support Plan
MAA--Mission Area Analysis
MACOM--Major Army Command
MACRIT--Manpower Authorization Criteria
MADP--Material Acquisition Decision Process
MAP--Manpower Analysis Paper
NCC--Mission Configuration Change
MD--Material Developers

MDC-Material Development Command
MEA--Maintenance Engineering Analysis
MENS--Mission Element Need Statement
MFK--Mission Flexibility Kit
MFP--Material Fielding Plan
MICOM--US Army Missile Command
MILPERCEN--US Army Military Personnel Center
MIRAT--MILPERCENT Initial Recruiting & Training Plan
MIST--Man Integrated System Technology
MLRS--Multiple Launch Rocket System
MOE--Measure of Effectiveness
MOS--Military Occupation Specialty
MPT--Manpower, Personnel, and Training
MRC--Materiel Readiness Command
MRF--Milestone Reference File
MRSA--US Army Material Readiness Support Activity
MTBF--Mean-Time Between Failures
MTBM--Mean Time Between Maintenance
MTBR--Mean Time Between Removal
MTOE--Modification Table of Organization Equipment
MN--Material Need
MTTR--Mean-Time-To-Repair
NET--New Equipment Training
NETP--New Equipment Training Plan
NETT--New Equipment Training Team
NSA--National Security Agency
OCO--Operational Capability Objective
ODP--Outline Development Plan
OLM--Organizational Maintenance
OOC--Operational & Organizational Concept
OPA--Other Procurement-Army
OSA--Orrice, Secretary of the Army
ODS--Office, Secretary of Defense
OT--Operational Testing
OT--(I, II, III)--Operational Test (I, II, III)
OTE--Operational Test and Evaluation

OTEA--US Army Operational Test and Evaluation Agency
OTP--Outline Test Plan
PCB--Printed Circuit Board
PERSACS--Personnel Structure and Composition System
PGSE--Peculiar Ground Support Equipment
PIP--Product Improvement Proposal
PLDMD--Platoon Leader's Digital Message Device
PM--Project Manager
PMP--Project Management Plan
POC--Point of Contact
POM--Program Objective Memorandum
PPBS--Planning, Programming, and Budgeting System
PQQPRI--Provisional QQPRI
PTTDAR--Personnel, Training, and Training Device Analysis Report
QQPRI--Qualitative and Quantitative Personnel Requirements Information
RAM--Reliability, Availability, Maintainability
RDTE--Research, Development, Test and Evaluation
REOC--Replenishment of Expendables and Operational Checks
RFP--Request for Proposal
ROC--Required Operational Capability
SA--Secretary of Army
SACS--Structure and Composition System
SECDEF--Secretary of Defense
SIMOR--Space Imbalance MOS.
SISMS--Standard Integrated Support Management System
SME--Subject Matter Expert
SMI--Soldier-Machine Interface
SMIR--Soldier-Machine Interface Requirements
SOW--Statement of Work
SPAS--Skill Performance Aids
SPLL--Self-Propelled Launcher Loader
SQT--Skill Qualification Test
SRC--Stadard Requirements Code
SSC-NCR--Soldier Support Center - National Capital Region
SSEB--Source Selection Evaluation Board
SSG--Special Study Group
SSI--Specialty Skill Identifier
STF--Special Task Force
STOG--Science and Technology Objectives Guide
TAADS--The Army Authorization Documents
TACFIRE--Field Artillery Tactical Fire Direction System
TAMMS--The Army Maintenance Management System
TC--Type Classification
TDR--Training Device Requirement
TDA--Table of Distribution and Allowances
T&E--Test and Evaluation
TECOM--US Army Test and Evaluation Command
TEMP--Test and Evaluation Master Plan
TIWG--Test Integrated Working Group
TM--Technical Manual
TMOS--Tentative Military Occupation Specialty
TOA--Trade-Off Analysis
TOD--Trade-Off Determination
TOE--Table of Organization and Equipment
TRADE--Training Devices
TRADOC--US Army Training and Doctrine Command
TRASSO--TRADOC System Staff Officer
TRITAC--Tri-Service Tactical Communication System
TSARCOM--US Army Troop Support and Aviation Material Readiness Command
TSM--TRADOC System Manager
USAAC--US Army Aviation Center
USAFAC--US Army Field Artillery Center
USAMMCS--US Army Missile & Munitions Center and School
USAREUR--US Army Europe
USASC--US Army Signal Center
USATSC--US Army Training Support Center
UTTAS--Utility Tactical Aircraft System
VCSA--Vice Chief of Staff Army